TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

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EXTENDING OPERATIONAL EXCELLENCE TO A COMPLETE PROJECT DELIVERY BY APPLYING COST MANAGEMENT METHODS

Master of Science Thesis

Examiner: Associate Professor Teemu Laine
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ABSTRACT

KIM AHONEN: Extending Operational Excellence to a Complete Project Delivery by Applying Cost Management Methods
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The study was driven in part from Metso's increasing need to extend its operational excellence to the end part of its supply chain. Simultaneously, the study contributes to management accounting theory. The aim of the study was to find out why and how managers should use management accounting information in the design of a process for delivering portable crushing plants. The study is divided into three parts. The first part comprises cost element mapping that aims to bring transparency to portable deliveries. The second part comprises the strategic choices that need to be considered for the best delivery in terms of costs and risks. In the third part, a process is created that can be used to price and control the delivery.

The theory used in this study was based on cost management and supply chain management theory, with the target being to create an effective delivery process. The background of this study is grounded in hermeneutics, and qualitative research methodologies were used. As the aim of this study was to create a new process and to solve a practical problem, the research approach used was constructive. The study was conducted as a single case, embedded case study. The data collection methods used were interviews, observations, and secondary data collection.

Management accounting can be used to derive multiple benefits in portable deliveries, such as improved cost efficiency and more accurate pricing. It can also be used to provide tools that measure and control the deliveries. Cost element mapping was the largest part of the study, and it was used to identify the cost structure and the variables behind the delivery. In addition, it also revealed how the costs and benefits were divided between supply chain partners and who controlled the costs. The major finding was that Metso's pricing was not completely accurate.

The most suitable strategy for a portable delivery is based on costs and delivery time. However, quality, technological risks, and risk of damaging the products also need to be considered. The created process comprised different methods for serious and casual inquiries. The process also included templates to price the delivery and to measure the performance of the delivery. The findings of this study can mainly be generalized to similar industrial equipment that can be transported containerized or in break bulk on a Ro-Ro vessel. The processes used are, however, bound to the assessed organization and cannot be generalized to other companies.

TIIVISTELMÄ

KIM AHONEN: Toiminnan tehokkuuden laajentaminen kokonaiseen projektitoimitukseen käyttämällä kustannusjohtamisen menetelmiä
Tampereen teknillinen yliopisto
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Avainsanat: kustannusjohtaminen, toimitusketjun hallinta, logistiikka, toiminnallinen erinomaisuus, projektinhallinta, toimitusten hallinta

Tutkimus syntyi Metson lisääntyneestä tarpeesta laajentaa sen toiminnan tehokkuus toimitusketjunsa loppuosaan. Samanaikaisesti, tutkimus vaikuttaa sisäisen laskentatoimen teoriaan. Tutkimuksen tavoitteena oli selvittää miksi ja miten sisäistä laskentatoimea voidaan käyttää hyödyksi, kun luodaan siirrettävien murskauslaitosten toimitusprosessia. Tutkimus voidaan jakaa kolmeen osaan. Ensimmäinen osa koostuu kustannuselementtien mallintamisesta, jonka tavoitteena on luoda läpinäkyvyyttä siirrettävien murskauslaitosten toimituksiin. Toinen osa koostuu strategisista valinnoista, joita tarvitsee käsitellä parhaimman mahdollisen toimitustavan löytämiseksi. Viimeisessä osassa luodaan prosessi, jota voidaan käyttää toimituksen hinnoitteluun ja hallintaan.

Tutkimuksessa käytetty teoria pohjautuu kustannusjohtamiseen ja toimitusketjun hallintaan, jonka pohjalta luotiin tehokas toimitusprosessi. Tutkimuksen taustalla esiintyi hermeneutiikka ja tutkimuksessa käytettiin laadullisia tutkimusmenetelmiä. Tutkimusotteena käytettiin konstruktiivista tutkimusotetta, koska tutkimuksen tarkoituksena oli luoda uusi prosessi ja ratkaista sillä käytännönläheinen ongelma. Tutkimusmenetelmä oli yhden kohteen tapaustutkimus, johon sisältyi useita analyysin kohteita. Käytetyt tiedonkeruumenetelmät olivat haastattelut, havainnoinnnit ja senkundääridatankeräys.

Sisäisestä laskentatoimesta voidaan johtaa useita hyötyjä siirrettävien murskauslaitosten toimitukseen, kuten parannettu kustannustehokkuus ja tarkempi hinnoittelu. Sisäisen laskentatoimen avulla voidaan myös luoda työkaluja, joilla toimitusta voidaan hallita ja sen suorituskykyä voidaan mitata. Kustannusten mallintaminen oli tutkimuksen suurin kokonaisuus, ja sitä käytettiin toimituksen kustannusrakenteen ja siihen vaikuttavien muuttujien selvittämiseen. Mallintaminen paljasti, että Metson kustannusarviot eivät ole täysin tarkkoja.

Paras strategia toimitukselle pohjautui kustannuksiin ja toimitusaikaan, mutta myös laatu, teknologiset riskit, ja toimituksesta aiheutuvat vahingot pitää huomioida. Luotu prosessi sisälsi erilaiset käytännöt virallisille ja epävirallisille toimituskyselyille. Prosessiin liittyi mallit, joilla toimitus voidaan hinnoitella ja millä toimituksen tehokkuutta voidaan mitata. Tutkimustulokset voidaan pääosin yleistää samankaltaisiin teollisuuden tuotteisiin, joita voidaan kuljettaa konteissa tai kokonaisina RoRo-aluksella, mutta käytetyt prosessit ovat sidottu tutkimuksessa käytettyyn organisaatioon.

PREFACE

This thesis was conducted between April and September 2017. The writing and the empirical part were done simultaneously. Writing the thesis was time consuming, sometimes enjoyable and in the end, it was very rewarding. The hardest part of the study was the beginning, where the relevant literature needed to be researched.

Conducting the thesis included a visit to the Middle-East, which brought its challenges, but was also the most exciting part of the thesis. Writing this thesis has been one of the longest projects I have conducted. It has also provided me with multiple new skills.

I would like to thank the second-floor personnel, for providing me a supportive work environment, and especially Julius Mäkelä and Kimmo Anttila for giving me the opportunity to conduct this thesis. Also, I am grateful for all Metso's partners who provided me valuable information and thus made the findings of this study matter.

From Tampere University of Technology, I would like to thank associate professor Teemu Laine for the guidance and tips throughout the thesis. I would also like to thank my girlfriend and my parents who have always been supportive of my studies.

Tampere, 25.9.2017

Kim Ahonen

CONTENTS

LIST OF SYMBOLS AND ABBREVIATIONS

40’ HC	40 Feet long high cubic container
40’ OC	40 Feet long open top container
AMET	Africa, Middle East & Turkey
CIS	Commonwealth of Independent States
COC	Carrier owned container
Crushing plant	Consists of two or more crushing units and the system portion
Crushing unit	A portable crusher that is mounted on tracks or wheels
Demurrage charge	Demurrage charge is paid when an importer/exporter has not picked up their containers from the port in the agreed time period
Detention charge	Detention charge is paid when an importer/exporter has rental containers in his possession, and has not returned them in the agreed time period
ERP	Enterprise resource planning
LC	Letter of credit. A written commitment issued by a bank, to pay the exporter once the agreed conditions has been met
Metso Eu1	Metso entity in Europe. Product and project owner.
Metso Eu2	Metso entity in Europe.
Metso Asia	Metso entity in Asia.
MFC	Manufacturing cost
RoRo	Roll on, roll off. A ship that is designed to carry wheeled cargo
SCM	Supply chain management
SCC	Supply chain costs
SG&A	Sales, general and administrative
SOC	Shipper owned container
System portion	Consists of conveyers and hoppers that are required for a working crushing plant

$C_{capital}$	cost of capital
C_{tot}	total costs
D_{bref}	days between reference dates
D_{ref}	reference date
D_{wavg}	weighted average days
D_{wavg}	weighted average days
V	mass
$WACC$	weighted average cost of capital

1. INTRODUCTION

1.1 Motivation of study

Metso is a global industrial corporation with three business areas: Minerals Capital, Minerals Services and Flow Control, of which Minerals Capital and Minerals Services belong to same Minerals reporting segment. The main products of Metso Minerals are mineral processing equipment, such as crushers and screens; serving Aggregates, Mining and Recycling industries. (Metso Corporation, 2016)

Metso has a high focus to minimize life cycle costs through technology, but also through operational excellence. Efficient supply chain management is the key driver for cost savings and Metso has already achieved considerable cost savings due to efficient procurement management and production management. The idea behind this study is to extend the same operational excellence to the end part of Metso's supply chain; from the factory — all the way to the overseas crushing and screening site. The results of this study are derived from a single product, but they can possible be extended to other industrial products as well.

The products used in this study are Metso's wheel mounted portable crushing plants (Figure 1), which consist of the crushing units and the system portion. If in assembled condition, the units can be easily moved with a truck tractor unit. After transportation, a plant can be set up in 12 hours, making it fully operational again. A single disassembled unit can be transported in three shipping containers, which can be a possibility for a competitive advantage. The benefits for the containerization can be cost savings, reduced risk of damages and a better availability in shipping.

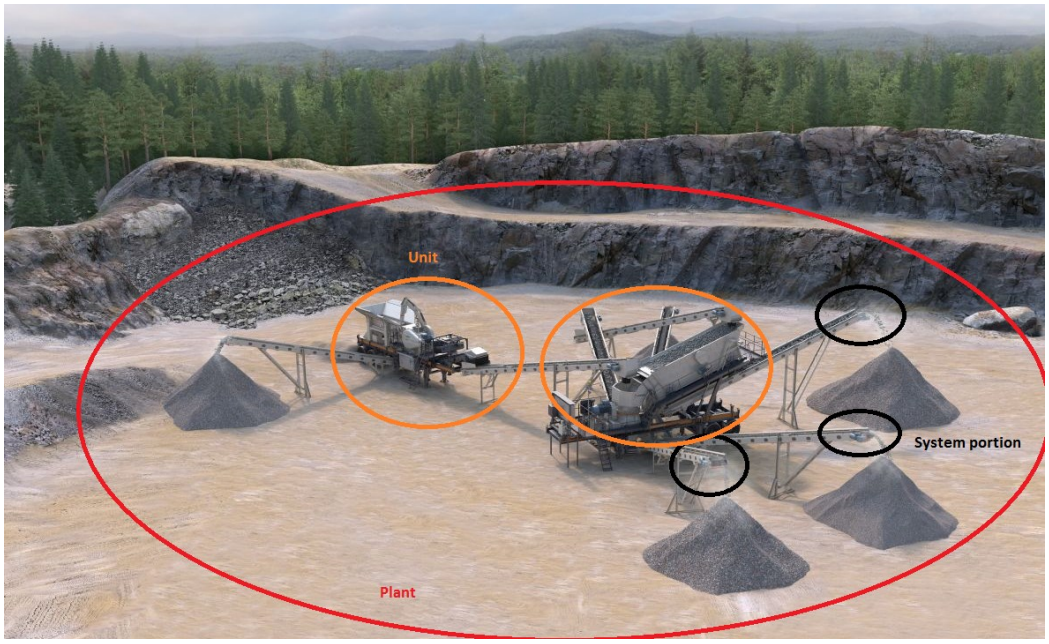

Figure 1. *Metso portable crushing plant (adapted from Metso NW Rapid™ crushing and screening plant, 2017)*

Recent studies have been conducted to find out how managers use management accounting information in their daily tasks. Yet, there is still much to be learned. Developing new processes to Metso provides an opportunity to conduct an explorative study of management accounting information in managerial use, in the context of delivering portable crushing plants.

The objective of this research is to find practical benefits for Metso, and to contribute to theory, of how management accounting information is used in managerial decision-making situations, and more precisely, how management accounting information can be helpful when creating a process for delivering portable crushing plants. The practical benefits for Metso, is to find the best balance between different transportation modes and scope of supply (readiness of the unit, complete or containerized). Further, to provide tools and templates to operate and manage different market areas. The study is limited to Metso's wheel mounted crushing units and the Aggregates markets, but the findings can possibly be generalized to other industrial products. The research problems can be driven from both theoretical and practical objectives.

The main research problem:

> Why and how should managers use management accounting information, when designing a process for delivering portable crushing plants?

The sub problems:

1. What kind of benefits can be driven from mapping the cost elements of the delivery?

2. What kind of strategies are suitable for the delivery, in the terms of costs and risks?
3. What kind of process should be used to price and control the delivery?

1.2 Methodological choices

This chapter describes the methodological choices and data collection methods shortly. Research methodology is further described in chapter 4. The following methodological choices are used:

- Scientific perspective – Hermeneutic
- Methodological approach – Qualitative
- Research approach – Constructive approach
- Research method – Case study
- Data collection methods – Interviews, observations and secondary data.

The research approach used in study is constructive, because the study tries to find a solution to a certain problem. A construction is created for this purpose. The research method used is case study. Yin (2014) states that the nature of the research problem dictates the method used. A case study is suitable when a research problem answers a "why" or "how" question. For primary data collection methods, interviews were used mainly and observations were used in a small portion of the study. Secondary data was used in many situations to validate the findings from primary methods.

1.3 Structure of the study and report

This study was executed in a way that adapts processes from the used research method and research approach. It started by finding out the practical problem that needed answering, and then gaining an overall knowledge of the context and the theories that are related to the matter. The theory gave the researcher an idea of what kind of framework should be used to execute the empirical part of the study. The empirical data was gathered and the patterns found were analyzed. Next, a relevant research question was designed. The research question was related to the practical problem and it could be answered from the patterns that were found from the empirical data. As the study is partly explorative, some of the found patterns are new.

The structure of the report is driven from the constructive research process. Constructive research approach and process is introduced more closely in the research methodology chapter (chapter 4). The structure of this study is shown in Figure 2.

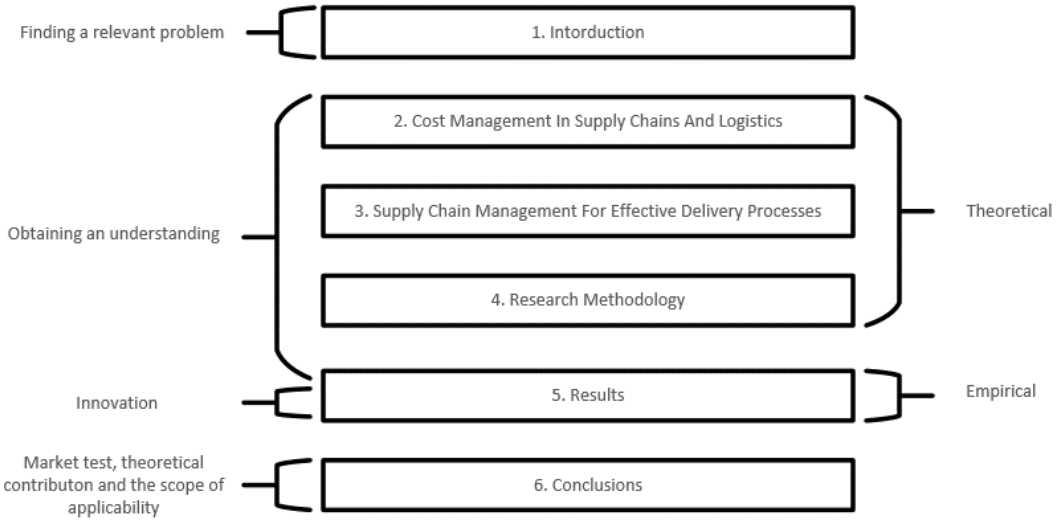

Figure 2. *The structure*

Finding the practically relevant problems are shown in chapter one. The second and third chapter contains the theoretical part of the study, which helps the researcher obtain an understanding of the topic. The fourth chapter describes the research methodology used. The fifth chapter is the empirical part of the study, which starts by mapping the costs structure. This still falls in the category of obtaining an understanding of the topic. The second and the third subchapter, is the innovation part where the actual construction is created. The sixth chapter includes the rest of the constructive research process. It assesses the implementation of the contribution, links to theoretical contribution and the scope of applicability.

2. COST MANAGEMENT IN SUPPLY CHAINS AND LOGISTICS

This chapter explains firstly the cost terminology that is used in cost accounting, and moves to theories of how management accounting information can and should be used in decision making situations. The chapter also explains activity based costing (ABC) and how it can be useful when controlling costs in supply chains.

2.1 Cost terminology

The cost terminology introduced in this chapter describes the terminology used widely in cost accounting. The terminology should not be associated to supply chains and logistics only, but to all cost accounting.

2.1.1 Cost object

In financial accounting, cost objects can be seen as units or entities that control certain resources and are responsible for performing certain tasks. These entities can be organisations, corporations or even an individual. In managerial accounting, cost objects do not necessarily have distinct responsiblities and obligations. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, p. 89) Atkinson, Kaplan, Matsumura, & Young (2012) defines a cost object to be anything for which a cost is computed. Examples of a cost objects can be activities, products, production lines, departments or organizations.

2.1.2 Types of costs

One traditional way of categorizing costs is to divide them in direct and indirect costs. Direct costs are costs that can be straightforwardly assigned to a single cost object. In car manufacturing, the cost for steel or tires would be material costs that are direct costs. Also, the costs from workers that are doing the installation of the tires, are counted as direct costs, as the costs can be easily traced to the car they are working on. (Horngren, Datar, & Rajan, 2002, p. 28) Any costs that cannot be categorized as a direct cost, is an indirect cost. A good way of testing if a cost is direct, is to eliminate the relevant cost object and to see if the organization still would need the resource that creates the cost. (Atkinson, Kaplan, Matsumura, & Young, 2012, p. 150)

Indirect costs cannot be traced to a single cost object, but are related to many. An example of this could be the administrative costs of a plant with many cost objects, and therefore the costs need to be allocated to each cost objects. (Horngren, Datar, & Rajan, 2002, p. 29) The act of dividing costs into direct and indirect costs is not always an unequivocal

process. For example, the costs for the department of salary are usually considered as indirect costs, but if the costs object would be the financial administration of the company the costs would be direct costs. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, p. 94)

An example of the complexity of direct and indirect costs can be driven from this study. Chapter 5.1.1 explains the overhead costs used. Technical support costs from the same person can be either direct or indirect, depending on the tasks performed. If the person is the commissioning supervisor in one of the cases, then the costs for the person are directly traced to the project. On the other hand, the same person could support other commissioning supervisors, these costs would be calculated as indirect costs.

Another traditional way to categorize costs is to divide them into variable and fixed costs. The division can be made by assessing the related level of activity or volume. (Horngren, Datar, & Rajan, 2002, p. 30) Variable costs will change if the related level activity will change, whereas fixed costs will stay unchanged. In reality, all costs are variable, if the time period is long enough, and the level of activity changes enough. Therefore, there are two factors that affect whether the costs are variable or fixed: the change of activity and the given time period. There are many different possibilities to divide costs into categories, such as joint costs and common costs, relevant and irrelevant costs or prospective and sunk costs. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, p. 95)

2.1.3 Cost centers

Responsibility centers can be cost centers, revenue centers, profit centers and investment centers. Each center has a manager that is accountable for the center's activities. (Horngren, Datar, & Rajan, 2002, p. 199) Horngren, Datar, & Rajan (2002) gives an example of the Marriot hotel where the maintenance department is a cost center, and the maintenance manager is responsible for costs only. Also the budged of the center is based on costs.

Cost center is a physical or functional part of an organization of which costs are followed and reported separately (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, p. 119). Cost centers are responsibility centers related to costs, but not to profits or levels of investment. The usual way of dividing costs centers is by processes or by organizations. (Atkinson, Kaplan, Matsumura, & Young, 2012, p. 494)

Cost centers can be used to examine the costs of an organization or to allocate costs to a product. Cost centers are usually built in a way that they comply with organizational limits, but for cost accounting they should be divided in a more detailed manner. The cost centers should be divided in a way that the accomplishments can be stated with a single unit of measure. This measure works also as the driver when allocating the costs. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, p. 119)

2.1.4 Cost drivers

An activity is a unit of work that consumes resources and thus creates costs. A cost driver is the level of activity that causally affects costs in a certain time period. If the relationship between the level of activity and costs is missing, then it is not the right cost driver. (Horngren, Datar, & Rajan, 2002, p. 32) The chosen cost driver should be the ultimate cause for the existence of the costs and chosen in a way that explains the behavior of the indirect costs in the long-run. If indirect costs pools include costs with different cost drivers, this may cause cost distortion, which means that the costs are not allocated accurately. (Atkinson, Kaplan, Matsumura, & Young, 2012, pp. 153, 156)

There are roughly three different types of cost drivers: transaction drivers, duration drives and intensity drivers. Transaction drivers measure volume, such as units, batches, orders or suppliers. They can be used if the change in volume reflects on the costs, meaning that all the transactions should be equal. Transaction drivers are considered easy to use and cheap. Duration drivers reflect on how much time the activities use and are relatively easy to use. The overall time consumed by activities are easy to follow, and the time consumed by cost objects can usually be estimated accurately. Intensity drivers are the most complex of the drivers and are based on the heterogeneity of transactions or time consumed. Performing a transaction might not always use the same amount of resources. Using intensity drivers illustrates this variability. Another way of overcoming this obstacle is to divide the activity into smaller activities. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, p. 141) An example of this can be show in chapter 5.1.1, where the activities could be bundled up, if all the activities would have the same hourly rates. As this was not the case, the notional "mother activity" was broken into smaller activities with different hourly rates.

2.2 Cost information in decision-making

The knowledge gained from cost accounting can be used in various decision-making situations, and it has been used for over a century. (Boyd & Cox III, 2010, p. 1880) Atkinson et al. (2012) suggest five decisions-making situations where cost information plays an important role:

1. Pricing
2. Product planning
3. Budgeting
4. Performance evaluation
5. Contracting.

There are two ways to use cost information in pricing, which depends on the type of the company's market. If the markets determine the prices of products, then the company can use cost information to determine whether it can compete profitably in these markets. If

the markets do not determine the prices, then the company can use cost information to set a price, that is driven from the costs. This is called cost plus pricing. In production planning, cost information can be used with a method called target costing. This means that the maximum costs of the product are preset, so that the product will be profitable. (Atkinson, Kaplan, Matsumura, & Young, 2012, p. 87)

Using cost information in budgeting is the most common of the five decision-making situations. By forecasting the future costs, a direction can be set for the company's budged period. In performance evaluation, information of actual costs is compared to estimates. This gives the company knowledge of how well the budgeting was done. Cost information in contracting can be relevant in a situation, where the company charges a customer for actualized costs instead of a fixed price. A margin can be added on top of the actualized costs. (Atkinson, Kaplan, Matsumura, & Young, 2012, p. 88)

In a study by Boyd & Cox III (2010), managers from 285 companies and 566 individuals were asked, that in which decision making situation cost information was the most important in. There were 18 different situations from which the managers could choose from. Eighty-five answers were received and the top six most important situations were

1. make vs. buy
2. product pricing
3. offer / discontinue products
4. vendor selection
5. equipment purchases
6. plant expansion / contraction. (Boyd & Cox III, 2010, pp. 1882-1883)

Another question in the same survey was used to ask the four most significant decisions that cost information was used to make in the past year. The same 18 situations from the previous question were used. (Boyd & Cox III, 2010, p. 1883) The top five results were

1. product pricing
2. offer / discontinue products
3. make vs. buy
4. plant expansion / contraction
5. equipment purchases. (Boyd & Cox III, 2010, p. 1884)

The results of the conducted survey show that according to managers, product pricing is the second most relevant situation where cost information should be used to make decisions; and product pricing is the top one decision cost accounting information is used to make. This illustrates the importance of cost accounting in product pricing.

Hall (2010) published a literature review of management accounting used in managerial decision-making. The aim of the review is to implicate how managers actually work, in order to understand what kind accounting information is helpful for managers. The review

contains three different findings. The first finding is that managers use management accounting information to get knowledge of their work environment, which can prepare them for future decision making situations. In this kind of role, managers prefer management accounting information that is easily understandable, not complex reports and analyzes. The second finding is that management accounting information is just one part of an information set, which should be compared to other information sources. The third finding is that managers share information verbally, rather than through written reports

Accounting information can be used in many ways to build managers' knowledge of their work environment, by making problems visible, that could not be seen through managers' daily activities. Van der Veeken & Wouters' (2002) argued that budgeted vs. actual costs can provide crucial information for senior managers, of the projects that are causing problems. The same study also argued, that operational managers had little use for financial measures and emphasized non-financial measures such as observations. (Hall, 2010, pp. 7-8) Developing knowledge of the work environment can be facilitated by concentrating on stimuli by highlighting key events and outcomes. McKinnon & Bruns (1992) argue that by combining accounting data with a report that recalls all the happened events, allows managers to associate events with financial performance. (Hall, 2010, pp. 10-11)

The uniqueness of financial data, compared to other information sources, is that financial data can be used as a dimension to compare the net effects of different types of operational factors. It also serves another purpose. Managers can use financial data as a common language, which managers can use to communicate with. Financial data is most important when the communicating managers have different back rounds. (Hall, 2010, p. 14)

Verbal communication is the primary way that managers prefer to pass accounting information to other managers, meaning also that accounting information can prompt managerial discussion. Verbal communication can be used to shape accounting information into operational concerns. Formal reports often serve as a reminder of what has been discussed before. (Hall, 2010, pp. 16-17)

2.3 Activity-based costing

Activity-Based costing was introduced in the 1980s, which was prompted from increasing overhead costs. ABC provided a new concept to allocate overhead costs more accurately than traditional costing methods. The increased overhead costs were not the only thing that drove the spread of ABC: the scale and scope of products were increased, and new information systems allowed more sophisticated costing systems to be developed. The problem of traditional costing methods was that all overhead costs could be allocated with only one cost driver, which does not consider that different cost objects use different amounts of activities. This enables the possibility that products can subsidize the costs of

each other, which can distort the profitability of different customers and promote wrong decision making (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, pp. 130-131).

In the early 1990s, Cooper & Kaplan (1991) published a study that criticized traditional costing methods. They argued that not all resources vary at the unit level. In addition to unit level activities, batch level, product sustaining and facility sustaining activities need to be recognized as well. This was a new opportunity for cost savings, as most of the savings in direct costs were already achieved.

2.3.1 ABC in supply chains

The fundamentals of activity-based costing define that all activities in an organization consume resources, which creates operating costs. ABC and modern logistics can be linked together. Each operation inside an organization can calculate their cost of logistics and allocate them for each job. Modern logistics are highly diversified, which can increase indirect costs compared to the direct costs. Logistic costs need to be accurate, which can promote the use of ABC. (Yan & Peng, 2015, p. 1018)

The first step for creating an ABC model for logistics, is to understand all the logistics activities that are originated from warehousing and transportation (Gríful-Miquela, 2001, p. 137). This extends to the part of the supply chain that is being assessed (Chaoyang & Ying, 2010, p. 1680).

The next step is identifying the right resources and the costs that the usage of these resources create. Once the costs of resources are clear, they can be allocated to the right activities and the costs of activities can be further allocated to cost objects. Cost drivers can be divided into two different groups: resource drivers and activity drivers, depending on whether they are used to allocate resources or activities. Figure 3 shows how the ABC process progresses. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, pp. 132-133)

Figure 3. *The progression of ABC (adapted from Suomala, Manninen, & Lyly-Yrjänäinen, 2011)*

Identifying activities can be done by interviewing staff. The key is to identify personnel that work on different activities and to figure out, which percentage of their time is used for these activities. The most relevant cost drivers should be identified by figuring out what would affect the time and effort spent in carrying out the activities. (Gríful-Miquela, 2001, p. 137)

Figure 4 gives a whole view of the principles of ABC. Direct logistics costs can be directly allocated to relevant cost objects, but indirect costs need further attention. As mentioned before, the allocation process is done in three parts. Firstly, the costs are allocated to resources. Resources can be linked together to form resource pools. This only applies to resources that are similar in nature and are used in the same way. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, pp. 134-136)

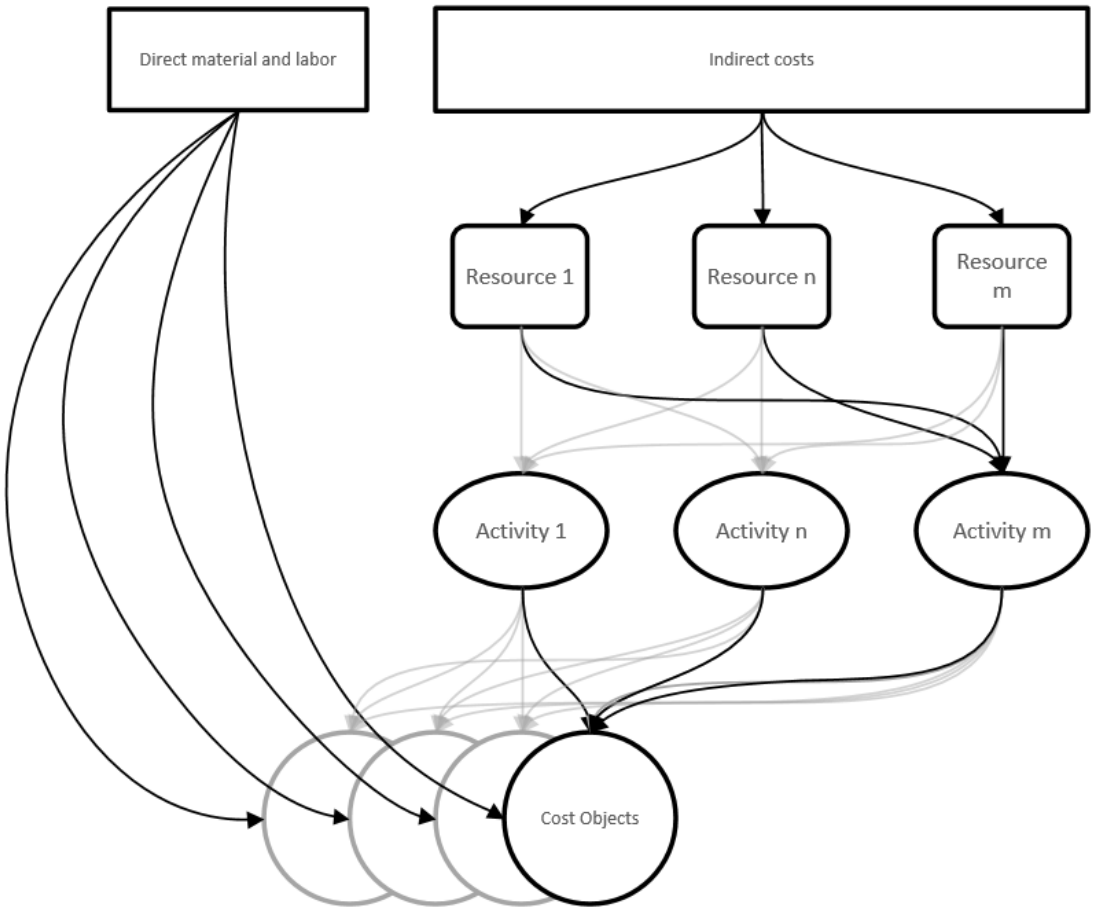

Figure 4. *The principles of ABC (adapted from Suomala, Manninen, & Lyly-Yrjänäinen, p. 2011)*

The second stage is to allocate the resources to different activities. The resource driver used should reflect on how the costs behave. The final stage is to allocate the cost of activities to the actual cost objects, using activity drivers. Also, the activity driver needs to be chosen so, that it reflects on what the activity produces. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, pp. 135-136)

In ABC bibliography, activities are often categorized in different levels. This is called cost hierarchy. The usual way of categorization is to divide cost in four different groups:

unit-level costs, batch-level costs, product-sustaining costs and facility-sustaining costs. For each different level, there are different cost drivers to identify the proper cost-allocation base. (Horngren, Datar, & Rajan, 2002, p. 149)

Unit-level activities follow directly the level of activity, such as the volume of a product. Activities that are associated with direct labor are unit-level activities. Also, some of indirect activities can vary with respect to the level of activity, making them unit-level activities as well. Batch-level activities follow the number of batches, not the directly the volume. An example of this can be the number of orders, where the costs do not depend on the number of order lines or the value of the order. Each order creates the same amount of costs. Product-level activities are based on the existence of a product, regardless of how many units of those products are made. Lastly, some costs can be traced to a customer or to the company itself. These costs will exist, if the customer or the company exists, regardless of what they produce. (Suomala, Manninen, & Lyly-Yrjänäinen, 2011, p. 139)

2.3.2 Controlling supply chain logistics costs with ABC

As all activities generate costs, supply chain logistics costs and the amount of logistics activities are related. Applying working ABC requires logistics activities to be improved iteratively to reduce the logistics costs. In addition to cost calculation, ABC can be used as an action to control costs. (Chaoyang & Ying, 2010, p. 1680) According to Chaoyang & Ying (2010), there are four actions to control supply chain logistics costs:

1. activity elimination
2. activity selection
3. activity reduction, and
4. activity sharing.

Logistics activities which are ineffective or has no value, should be identified and then given up. This is called activity elimination. Activity selection is to select the best activities from a selection of different logistics activities that exclude each other. Different logistics activities have different cost structures; the key is to select the cheapest without losing quality. Activity reduction can be used to improve efficiency in some activities by decreasing the time and resourced used. By doing something faster with the same quality, costs can be reduced. Lastly, activity sharing is improving efficiency with the scale of economy. Making a new product that uses existing distribution channels will reduce the allocated costs for each product. (Chaoyang & Ying, 2010, p. 1680)

3. SUPPLY CHAIN MANAGEMENT FOR EFFECTIVE DELIVERY PROCESS

This chapter explains the differences between logistics management and supply chain management, and what kind of benefits can be driven from supply chain integration. It also explains the types of costs that should be considered when the supply chain is assessed and it introduces supply chain costing as a method to measure supply chain costs.

3.1 Logistics and supply chain

The need for supply chain management (SCM) was originated from companies' need to improve their profitability and lower their prices. This created pressure to cut down the costs of all processes. SCM was firstly introduced in the late 1950s, but its real significance was discovered later on, which led to its increased study in the 1980s and 1990s. (Petersson & Segerstedt, 2013, p. 94) With well executed SCM a company can achieve a sustainable competitive advantage (Seuring, 2002, p. 2).

There is a variety of different definitions for supply chain management, but there seems to be a rough consensus. SCM consists of all activities, that flow raw material in the chain, until it is in the form of a final product, and in the hands of a customer. (Petersson & Segerstedt, 2013, p. 357) SCM is to manage these activities as whole and with improved relationships. This definition emphasizes that management of information and material flow need be combined with the management of relationships. (Seuring, 2002, p. 2)

Logistics means a framework that has been built to smoothly flow materials and information throughout an organization (Chaoyang & Ying, 2010, p. 1679). An organization is formed by several different activities. SCM functions as the linkage between these activities and other entities such as suppliers, distributors and customers. Logistics management is a part of supply chain management and is used to execute logistics efficiently. There is only a single organization involved in logistics management, whereas in supply chain management there are multiple organizations involved. Figure 5 illustrates the supply chain concept. (Christopher, 2011, pp. 2-3) This study concentrates on the end part of the supply chain (highlighted in Figure 5) and it assesses the logistics across multiple organizations.

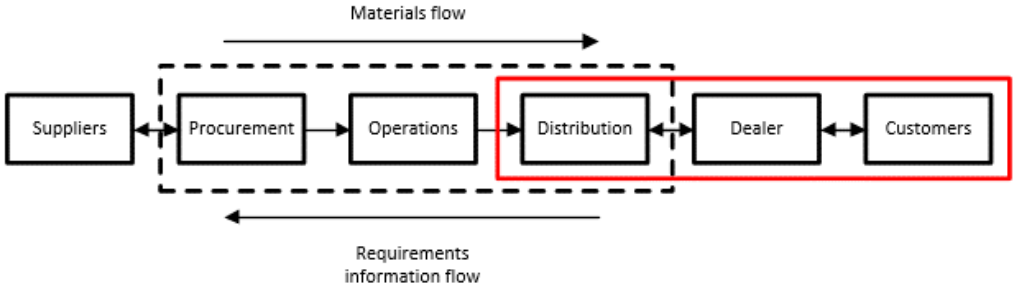

Figure 5. *Supply chain logistics (adapted from Christopher, 2011, p. 11)*

A traditional view of organizations is that they view themselves as independent entities. To survive, they need to compete with others and exceed their performance. This can be a self-destroying view of the chain, as good relations add value to the organization. Even though SCM is integrating activities in the chain, it is not the same thing as vertical integration, where companies acquire others in the chain to achieve better margins. An increasing trend with organizations, is to focus on their core competences and outsource the rest, often to offshore factories. Sometimes even manufacturing can be outsourced. (Christopher, 2011, p. 13)

It used to be common to think suppliers and customers as individual players, not as a cooperation. This meant that companies tried to achieve cost saving with the expense of others, which in the long run did not make them more competitive. The companies with knowledge in SCM recognizes this, and integrates the supply chain, making it more competitive. Figure 6 illustrates the stages of integration in supply chains. (Christopher, 2011, p. 14)

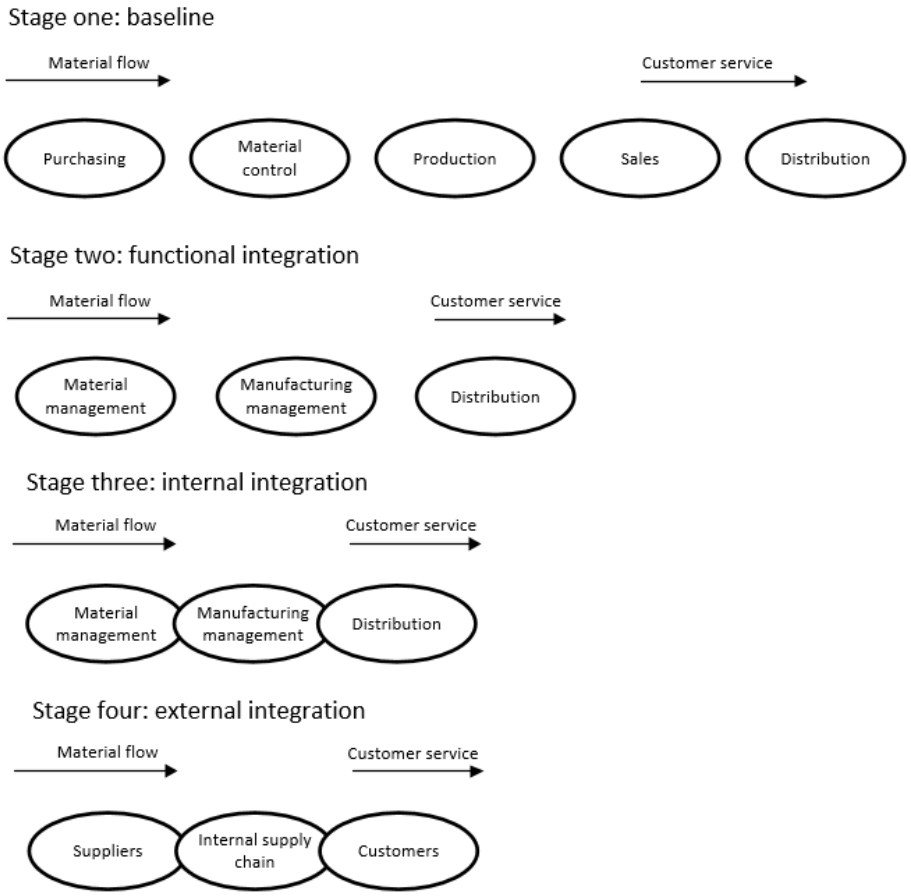

***Figure 6**. Integrating the supply chain (adapted from Christopher, 2011, p. 14)*

SCM is an evolved version of logistics management, which extends the optimized material and information flow through organizational boundaries. Figure 6 shows the evolution of logistics management to SCM. The first stage is where each unit inside the organization works in complete isolation without regarding the other units. As all units seeks to flow material through their unit in the most efficient way, they can cause problems to other units e.g. in built up inventory. The second stage is where the degree of integration is a notch higher and extends to the adjacent functions. The third stage is a full integration inside an organization and the fourth stage is where the integration has extended both upstream and downstream, through organization limits. (Christopher, 2011, pp. 14-15)

Metso is a typical example of a business which adapted the "core business" strategy and outsourced the rest. Metso is still a turnkey supplier for its customers, which is possible through Metso's core competences, such as its operational excellence, which is another word for good SCM. (Metso Corporation, 2016) The operational excellence is highlighted in this study as the scope is the end part of the supply chain, rather than Metso itself. By bringing cost savings to the whole chain it is easier to make distributors more comfortable to deliver crushing plants to customers.

3.2 Types of supply chain costs

Many companies only recognize costs that are originated within the company. Due to outsourcing, relevant costs can originate outside the company's boundaries. A supply chain view of the costs extends the cost to other organizations, which can create a more accurate picture of the real costs that apply. Accurate view of supply chain costs (SCC) help managers to make better decisions. (Petersson & Segerstedt, 2013, pp. 95-96)

Petersson & Segerstedt (2013, p. 359) suggest that supply chain costs that are controlled by an organization, consists of all relevant costs inside the organization. Relevant costs can be broken down into different functional areas which are each responsible for their own costs. SCC can be divided into six areas, if the supply chain bear installation costs that are included in the sales price and not separated. These areas are

1. Manufacturing costs.
2. Administration costs.
3. Warehouse costs.
4. Distribution costs.
5. Capital costs.
6. Installation costs.

Manufacturing costs include direct material, direct labor and production overhead costs. Administration costs include procurement and order office costs. Sales and general costs are not included, because they are not a part of the supply chain. Warehouse costs include costs from storing inventory. Distribution costs include inbound and outbound logistics costs and the administrative costs that are related to logistics. Capital costs are derived from invested capital and installation costs are derived from installation or commissioning of the final product. These areas can be further divided into more detailed groups that are shown in Figure 7. (Petersson & Segerstedt, 2013, p. 359)

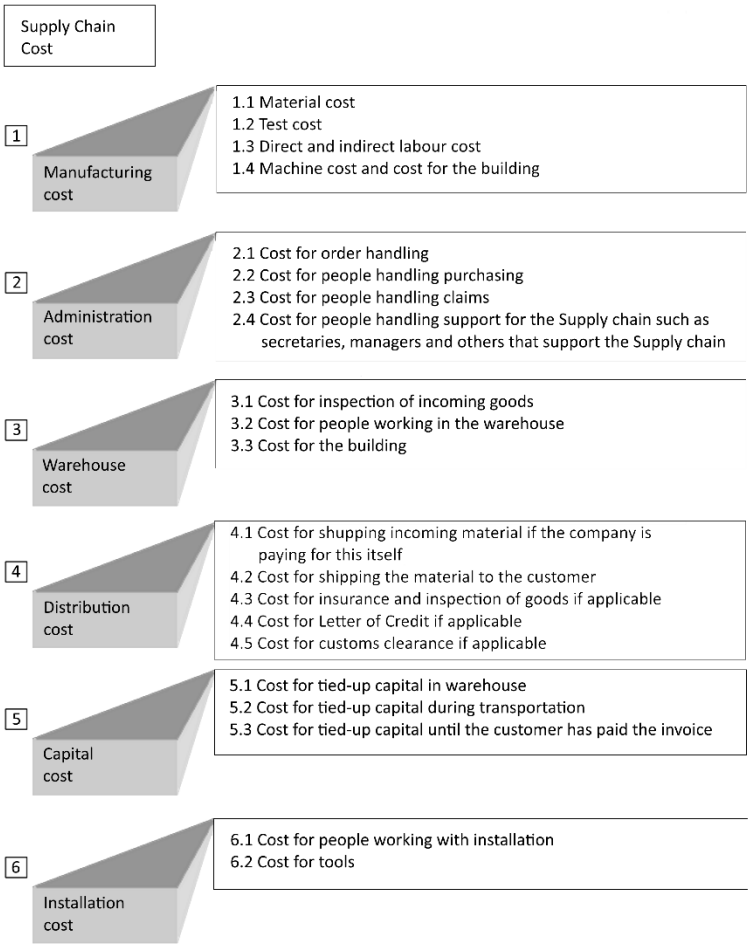

Figure 7. *Contents for supply chain costs (adapted from Petersson & Segerstedt, 2013, p. 360)*

As partly mentioned earlier, SCC do not include the costs for research and development, sales, general administration and human resources. Thus, SCC should be used exclusively to evaluate supply chains. SCC should also be used in a full cost analysis, but other costs should be included as well. SCC can be used in many different situations e.g. in a decision-making situation for outsourcing or insourcing, or to reduce costs in a supply chain. (Petersson & Segerstedt, 2013, p. 359) In this study SCC are used to create cost visibility in the end part of a supply chain, and to form a process for accurate pricing and controlling of a delivery.

Petersson & Segerstedt (2013, p. 100) argue that it is very important to have an intact view of the SCC or the cost reductions achieved can increase costs in other parts of the supply chain. On the other hand, some cost elements in the supply chain can be excluded, if the elements are not seen as relevant. Manufacturing costs, Procurement costs and other costs that are not related to the end part of the supply chain, are excluded from this study. Also, some costs are partly excluded, as support function costs that are related to the manufacturing of the products are not included. This study does not affect any part of the

production process and thus it cannot increase or reduce the cost of production, and create an illusion of false cost savings.

Based on the SCC model by Petersson & Segerstedt (2013, p. 360), the cost types in this study are: Administration costs, Distribution costs, Capital costs and Installation costs. Administration costs correspond to support function costs and order handling costs. There are no warehouse costs, as all products are delivered directly to the customer.

3.3 Measuring supply chain costs

Supply chain costing by LaLonde & Pohlen (1996) is a way of measuring costs of supply chain activities. It is used to evaluate the overall effectiveness of a supply chain. Supply chain costing uses techniques from other costing methods such as ABC. ABC itself is not sufficient enough to be used in SCM, as ABC evaluates how the supply chain partners affects the costs of a single organization, instead of thinking of the supply chain as a whole. Supply chain costing enables supply chain partners to find non-value-added activities in the chain, and helps them to strategically position activities to partners, who can perform them as well as possible. Figure 8 illustrates the difference between the reach of ABC and supply chain costing. (LaLonde & Pohlen, 1996, pp. 3, 5)

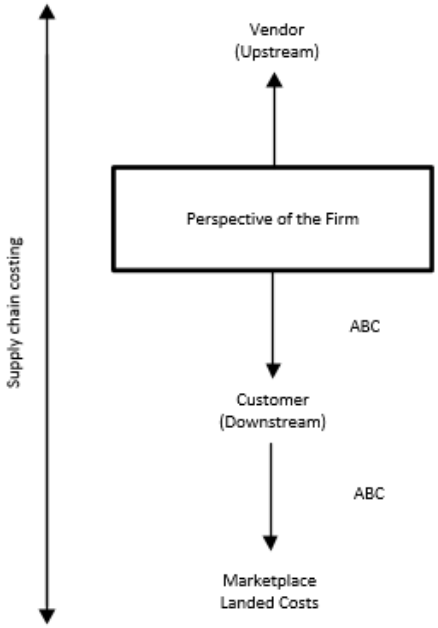

Figure 8. *Supply chain costing compared to ABC (adapted from LaLonde & Pohlen, 1996, p. 5)*

Supply chain costing can be used as a tool for managers to evaluate performance in supply chains. It does not substitute traditional cost accounting or general ledger accounting. Supply chain costing can be divided in six steps which are

1. analyzing supply chain processes
2. breaking processes down into activities
3. identifying the resources required to perform and activity
4. costing the activities
5. tracing activity costs to supply chain outputs, and
6. analysis and simulation. (LaLonde & Pohlen, 1996, p. 5)

Analyzing supply chain process means identifying the major functions of each member of the supply chain. The task is complete when the major functions and supply members has been placed in the flow diagram. Next is breaking down the process into activities, which means breaking down the major functions. The activities should be decomposed until the activities are relatively homogenous, which means that by decomposing them even more would be pointless. The objective of this step is to create a flow diagram of all activities in the supply chain. (LaLonde & Pohlen, 1996, p. 6)

The next step is identifying the resources required to perform and activity, which means assigning costs to activities using the same method as in ABC. The difference between supply chain costing and ABC is that supply chain costing extends through company boundaries. Some activities may extend through internal organizations or even through company limits and consume resources from each partner in the supply chain. Accurate costing would require the full cooperation of each partner to get the actual costs. Luckily this barrier can be overcome by using expert knowledge. The required experts can be internal or external personnel. The next step is costing the activities. An activity cost includes the direct and indirect costs that are consumed when the activity is performed. The activity cost means the total costs per one unit of the cost driver (LaLonde & Pohlen, 1996, pp. 6-7). In other words, the activity cost can be driven by dividing the total costs with the total amount of the driver. For example, total costs divided by total hours of work, which gives the price for one hour. This is the activity price.

Tracing activity costs to supply chain outputs, means allocating activities to the right outputs, using the right drivers. By this allocation, all the resources that were first allocated to activities are now further allocated to the products, customers or distribution channels that uses them. (LaLonde & Pohlen, 1996, p. 7) LaLonde & Pohen (1996) argues that tracing costs to outputs can provide knowledge from several matters such as

- profitability by customer, product, or supply chain
- the value-added versus the cost incurred by the final customer
- non-value-added activities which can be targeted for elimination
- potential for more cost-effective trade-offs within the supply chain
- opportunities to employ restructuring or “functional shiftability” to align activities with the firms which can most effectively perform them within the supply chain.

Supply chain costing is a tool to analyze the real cost drivers for each activity and how different variations in product flow or customer demand will affect the overall costs. The information gained can be used in other analyses. Supply chain costing can be also used to analyze how one part of the chain will affect the rest. Simulation or sensitivity analyses can be done by altering parts of the supply chain and calculating the effects, with wanted variables. (LaLonde & Pohlen, 1996, pp. 7-8)

3.4 Theory summary

The intention of this summary is to interpret how the delivery should be done according to cost management and supply chain management literature. Atkinson et al. (2012) listed five decision-making situations where cost information plays an important role. Three of these decision-making situations are relevant in this study, which argues that cost information should be used or at least considered when creating the delivery process. The created process in chapter 5 is used primary for pricing and controlling a delivery, but it can be used for budgeting a delivery and evaluating the performance of a delivery as well. Also, the study by Boyd & Cox III (2010) consolidates the argument for using cost information in the pricing process.

The research by Petersson & Segerstedt (2013) shows the relevant costs in the supply chain. The costs can be broken down into different functional areas: manufacturing costs, administration costs, warehouse costs, distribution costs, capital costs and installation costs. The study excludes manufacturing costs, because they are not a part of the end part of the supply chain. Sales costs and general costs are excluded as well, because they are not relevant when assessing the supply chain.

LaLonde & Pohlen (1996) add a way of measuring supply chain costs of supply chain activities to this study. The process of supply chain costing uses techniques from other costing methods like ABC, and it can be used by managers to evaluate the performance of supply chains. It also suggests that simulation or sensitivity analyses should be used to assess different effects in the supply chain.

The findings from Hall (2010) implicates how managers work, in order to understand, what kind accounting information is helpful for managers. The theories found, were used in the creation of the delivery process, and to create the research questions, and it works as the basis of how this study is set in the spectrum of management accounting literature. There are also several findings that are compared to the findings of the empirical part of this study (pattern matching). The findings from Hall (2010) suggest that senior managers use management accounting information as to compare actualized and budgeted costs, and to separate the bad projects from the good ones. Another finding was that management accounting information should be one part of a wider information set, instead of being the only form of information. Related to this, it was also found that when

writing a report of a project, it should contain information of the activities that happened and accounting information that covers the time period.

4. RESEARCH METHODOLOGY

This chapter elaborates the scientific and data collection methods used in this study. The usual structure in each sub chapter is, that firstly the possible methodological choices are introduced, and then the selected choice is explained in detail. In the data collection sub chapter, it is also explained, how the methods were used in this study.

4.1 Scientific perspective

Two mostly used scientific perspectives in the field of industrial management are positivism and hermeneutics, of which hermeneutics is used in this study. The principles behind positivism is that the results of the study should always end up with the same results. This idea is driven from the idea that information should be based on facts. The data used is usually quantitative. This differs from the principles of hermeneutics where the results are driven from the understanding of the researcher, and the same results with different researchers cannot be guaranteed. (Olkkonen, 1994, p. 35)

Hermeneutics strives to gain information from empirical data through induction. The used data is usually narrow and qualitative. Hermeneutics can be used when the research problem is difficult to structure, it can be divided into multiple sub problems and there is no theoretical background of how to approach the problem. A deep analysis needs to be used to create new theories or hypotheses. (Olkkonen, 1994, p. 37)

4.2 Methodological approach

One way of categorizing methodological approaches is to divide them into quantitative and qualitative research. Quantitative research uses numeric data, and is often related with methods that generate or use numeric data. In contrast, qualitative research is usually related with methods that generate or use non-numeric data. In reality, the distinction is usually not this absolute. Many business management research designs tend to mix quantitative and qualitative elements. (Saunders, Lewis, & Thornhill, 2012, p. 161)

Some researchers argue that the methodological choices should be driven from theory. As researchers specialized in different approaches has a different view of theory, the best way to select the approach is to use the research problem, and the target of the study to dictates that which approach should be used. As there can be multiple research problems — there can be multiple approaches. Quantitative research has its focus on verifying something with quantitative methods and qualitative has its focus on understanding a context. (Hirsijärvi & Hurme, 2008, pp. 25, 27) Qualitative research can be referred as naturalistic, because it focuses on studying a phenomenon in its natural setting. This study

is qualitative, as qualitative methods are used to analyze the data and the purpose is to understand the idea behind the delivery.

4.3 Research approach

There are different research approaches that can be used in the field of business economics. The right research approach is usually defined by several things: the type of the research problem, level of knowledge at the starting point, source material available and desired results. (Olkkonen, 1994, p. 59) There are various ways of categorizing research approaches. A commonly used one in Finnish management accounting researches is by Neilimo & Näsi (1980), where the approaches are divided in four; conceptual approach, decision-oriented approach, nomothetical approach and action-oriented approach. (Kasanen, Lukka, & Siitonen, 1993, p. 255) This kind of categorizing is coarse, but it reveals the general properties and opportunities behind each approach. It also works as a framework for different approaches, even though it doesn't necessarily represent all possibilities. In addition to Nelimo & Näsi's view; Kasanen, Lukka & Siitonen (1991) have added the constructive approach. (Olkkonen, 1994, pp. 60-61) These approaches can be divided with respect to two axes: theoretical-empirical and descriptive-normative (Figure 9) (Kasanen, Lukka, & Siitonen, 1993, p. 257).

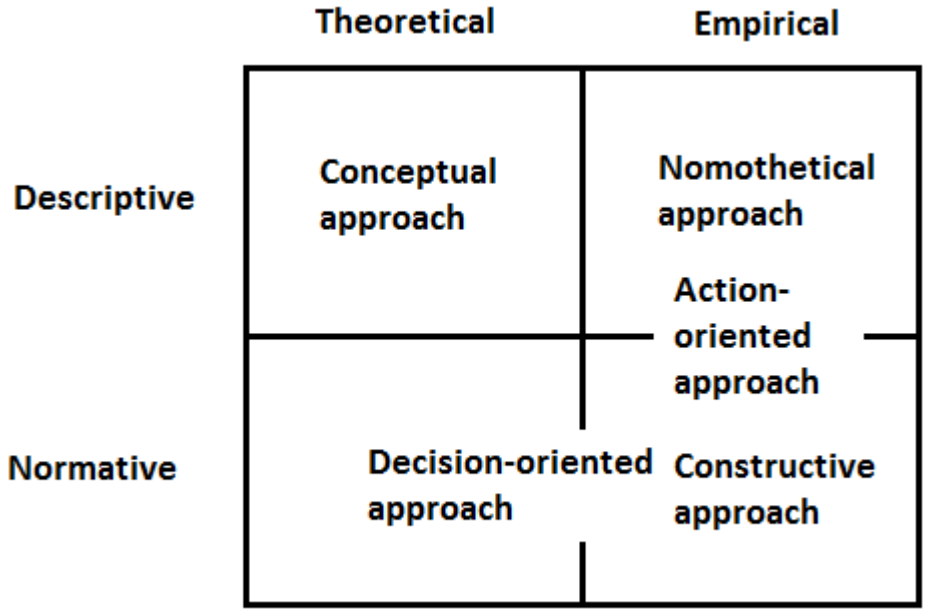

Figure 9. *The relationship between different business economics research approaches (adapted from Kasanen, Lukka, & Siitonen, 1993, p. 257)*

One quality of the constructive approach is that it aims to solve a certain problem, which makes it highly normative. The normative feature makes it resemble decision-oriented approach. On the other hand, constructive approach resembles action-oriented as both have connections to practice through empirical qualities. (Olkkonen, 1994, p. 60) This

study is clearly constructive, as it starts from a practical problem and aims to find a method for solving it. In contrast to action-oriented approach, which aims to understand the underlying problem due to the related hermeneutic methodology (Olkkonen, 1994, p. 72). Another quality of the constructive approach is its market-based validation of the results. There are three different market tests that are based on the concept of innovation diffusion:

- weak market test
- semi-strong market test, and
- strong market test.

Passing a weak market test means that a manager of a business unit has adopted the construction in question in his or her decision making. A semi-strong market test is passed if the construction has been widely adopted by companies. Passing a strong market test means that there is evidence of better financial results that have been achieved with the construction. (Kasanen, Lukka, & Siitonen, 1993, p. 253) This study passes the weak market test, as it has been adopted to use by Metso.

When using constructive research approach, the structure of the study should follow a formal process. The constructive research process can be divided into six phases, which may vary in different cases (Kasanen, Lukka, & Siitonen, 1993, p. 246):

1. Find a practically relevant problem which also has research potential.
2. Obtain a general and comprehensive understanding of the topic.
3. Innovate, i.e., construct a solution idea.
4. Demonstrate that the solution works.
5. Show the theoretical connections and the research contribution of the solution concept.
6. Examine the scope of applicability of the solution.

From these six phases, the third phase is the most critical part, as there is no point of continuing the study, if it is impossible to form a construction that works as a solution for the problem. (Kasanen, Lukka, & Siitonen, 1993, p. 247)

4.4 Research method

According to Yin (2014), there are three different conditions that should be regarded, when selecting a research strategy: “the type of research question posed, the extent of control a researcher has over actual behavioral events, and the degree of focus on contemporary as opposed to entirely historical events”. A case study has a “how” or “why” research question, the researcher has little or no control of the occurring events and the subject is studied in a contemporary context. (Yin, 2014, pp. 10, 12) If a case study is used for an explanatory or exploratory research, it can also answer to “what” type

of research question. (Saunders, Lewis, & Thornhill, 2012, p. 179) This study fulfills all the previously described requirements. The main research question is a "how" question and the sub questions are "what" questions.

When the research question of a study is "how" or "why", there are three different possible methods to use: a history, a case study or an experiment (Yin, 2014, p. 12). A case study is the relevant when the subject of the study is a real-world case, where an understanding of the context is relevant. An experiment separates the studied phenomenon from its context, which means having a controlled environment. Also, it is difficult to understand context from a survey. What separates a case study from a history, is that a history is studying noncontemporary events. A history and a case study can sometimes overlap, if the studied phenomenon has happened in the recent history. (Yin, 2014, p. 16)

There are four types of designs for a case study: single-case holistic, single-case embedded, multiple-case holistic and multiple-case embedded. The differences can be divided in two dimensions: single case – multiple cases and holistic case – embedded case. (Yin, 2014, p. 50) A single case should be used when the case is critical, extreme or unique; or in contrast, if the case represents a typical case, or if the case is a phenomenon that few have studied before. (Saunders, Lewis, & Thornhill, 2012, p. 180) The difference of a holistic case and an embedded case, is in the units of analysis. An embedded case contains multiple units of analysis, e.g. projects inside a program. (Yin, 2014, p. 55) The context of this study is unique and few have studied it before, therefore a single-case design is suitable. Also, there are multiple subunits that are analyzed, making it an embedded case. Even though the three different units of analysis in this study are referred to as "cases" in the next chapters, they are not actual separate cases.

A case study uses many same data collection methods as a history, adding interviews and observations to the equation (Yin, 2014, p. 12). The sources of evidence used in a case study can be: interviews, observations, physical artifacts and secondary data (Yin, 2014, p. 106). The methods used in this study are: interviews, observations, and secondary data. Using multiple sources for triangulation affects the validity of the study.

There is also a lot of criticism that speaks against case studies. One of them is that case studies lack rigor, meaning that ambiguous evidence has been used to affect the results of the studies. The reason can be a lack of methodological texts with strict procedures to be followed. Another criticism is that generalizations cannot be made of single cases, and case studies can rely only on analytic generalization instead of statistical generalizations. Lastly, case studies can take too long and they can result in massive documents. (Yin, 2014, pp. 20-21)

Yin (2014, p. 71) introduces a four-step procedure which can be used to prepare well for doing a case study: training for the specific study, developing a protocol for data

gathering, screening candidate cases and conducting a pilot case. The training for this study was made by familiarizing Metso's products and the organizations related. The data gathering protocol was not developed very accurately in the beginning. The personnel used for interviews were gathered through snowball sampling and in the beginning, there was not sufficient knowledge of who to interview. The screening of candidate cases was not required, as the case was assigned by Metso and no pilot was made.

When conducting a case study, theory should be used for Generalizations. As mentioned before, there are two ways of generalization: statistical generalization and analytical generalization. Statistical generalization is not relevant for a case study. It is commonly used in surveys, where the empirical data collected works as a sample of the whole population. Analytical generalization is relevant for a case study. Analytical generalization can use theory in two ways: either to validate or reinterpret old theories, or to create new theories. (Yin, 2014, pp. 40-41)

There are several different types of case studies, differing by their nature and objective. Three common types can be recognized from most sources. These are descriptive, explanatory or exploratory case studies. Erikson & Koistinen (2005) describes descriptive case study to be narrative, with the objective to describe a culture and the meanings behind it. This differs from explanatory case study, where the objective is to explain a certain phenomenon with formerly introduced theories; and from explorative case study, where the objective is to create new theoretical ideas, propositions or hypotheses, that can be tested in the same study or in future studies. This study is explorative, with the objective to create new theories. It differs from former studies, by going deeper in this particular context. It also has explanatory features, as the findings can be compared to findings from slightly different contexts.

Yin (2014, pp. 136-142) introduces four different analytic strategies to conduct a case study: relying on theoretical propositions, working data from the ground up (grounded theory), developing a case description and examining plausible rival theories. The fourth of these strategies should be used with one of the other three. Yin (2014, pp. 143-164) also introduces five analytic techniques: pattern matching, explanation building, time-series analysis, logic models and cross-case synthesis, which should be used with the chosen strategy. The strategy used in this study was to work the data from ground up, and no theoretical propositions was made at the beginning of the study. Theory was still used for finding out the best structure for collecting the empirical data. For the analytic technique, pattern matching was used to compare the patterns discovered from the empirical part, to the patterns in theory. The patterns from theory are from similar contexts, the exact context of this study has not been studied before.

A research design should represent a logical set of statements and therefore it should be evaluated with certain logical tests. Yin (2014, p. 45-49) introduces four tests to determine the quality of research designs. The tests are: construct validity, internal validity, external

validity and reliability. Construct validity is related on data collection and weather the measures used actually reflect on the concept being studied. Construct validity can be enhanced by using multiple sources of evidence, establishing a chain of evidence and having key informants read the draft of the study. Internal validity is related to the data analysis. It is used to test whether the findings of the study are justifiable, by finding causal relationships. Also, the interpretations made by the researcher affects internal validity. Good internal validity can include pattern matching, explanation building, rival explanations or logical models. External validity relates to the generalization of the findings. In a single case study, external validity should be enhanced by using theory. The last test is reliability. If the conducted study would be replicated in the future by another researcher, the findings from the study should be same. Reliability can be assured by using a case study protocol or by using a case study database.

4.5 Data collection methods

This chapter describes the data collection methods used in the study. The methods used were interviews, observations and secondary data. Observation was used for collecting a marginal amount of data and that is why it is described only briefly.

4.5.1 Interviews

A common if not the most important method of collecting primary data in a case study, is a research interview. In an interview situation, the researcher is directly in contact with the interviewee, and gives the researcher a chance to direct the data acquisition. It also gives a possibility to reveal the motivations behind the answers. Interviews should be used when the topic is little known, and the interviewer has little chance to anticipate the direction of the answers. An interview gives the researcher a possibility to ask follow up questions from the interviewee. (Hirsijärvi & Hurme, 2008, pp. 34-35)

Yin (2014) describes interviews used in case studies as guided conversations. This type of interview refers to an unstructured interview, which is one of three types of interviews. (Yin, 2014, p. 110) The other two are structured interview and semi-structured interview. There are also other ways of categorizing interviews, but this is the most commonly used. The difference of the types lie in the level of structuration. A structured interview uses predetermined questionnaires and resembles a survey. Asking the questions should be done without any bias, which means that the questions need to be asked just as they are written and with a regular voice. (Saunders, Lewis, & Thornhill, 2012, p. 374) A structured interview is best when the researcher wants to test formal hypotheses and quantify the answers. (Hirsijärvi & Hurme, 2008, p. 45)

A semi-structured interview is not as standardized as a structured interview. In a semi-structured interview the researcher has a list of themes to be discussed and perhaps some pre-made questions. The nature of the interview can vary depending on the situation. The

researches has an option to ask specifying questions, if he wants deeper knowledge of a certain theme. (Saunders, Lewis, & Thornhill, 2012, pp. 374-375)

The unstructured interview that was commonly used in case research, is the most informal of the three possibilities. The interviewer does not have a list of questions to be asked, but he still needs to know which themes to pursue. The interviewee is given free hands to talk about anything that is related to the topic. (Saunders, Lewis, & Thornhill, 2012, p. 375) The interviewer's job is to deepen the answers of the interviewee and to build the rest of the interview from the answers. The interview resembles a conversation. (Hirsijärvi & Hurme, 2008, p. 46) An unstructured interview can give the deepest possible understanding to the theme that the researcher decides to pursue. (Saunders, Lewis, & Thornhill, 2012, p. 375)

According to Yin (2014) recording interviews is a question of personal preference. The interviews in this study were not recorded nor transcribed, as it was relatively easy to ask the interviewees the same questions again, if the answers were forgotten. Of course, the information gained from the interviews were written down immediately after the interview. The internal personnel interviewed were Sales Support Managers, a Logistics Coordinator, a Product Manager, a Financial Business Partner and a former Export Manager. External interviewees were a Research & Development manager from a partner company and a Business Development Manager from Metso's freight forwarder.

The interviews used were mostly unstructured. The external interviews were semi-structured as it was easier to send the interviewees a list of question, so they had to prepare for answering the themes the researcher wanted. The internal interviews were mostly spontaneous and building questionnaires would have pointlessly consumed more resources.

4.5.2 Observation

Observation is a less popularly used data collection method in management research, if compared to interviewing. Observation can be used to collect data of what people do and how they do it in their natural surroundings. Observations can be divided in two categories. Participant observation is a qualitative way of doing observation, that can be used to discover meaning of people's actions. Structured observation is a quantitative way of doing observation, by calculating the number of actions people make. (Saunders, Lewis, & Thornhill, 2012, p. 340)

The way of doing observation in this study was participant-observation and the role of the researcher was a complete participant. The researcher was observing the times used to assemble a portable crushing plant, but the intention was kept in secret. The researcher was also supervising the assembly of the plant, which means that his actions had a great

impact on the time used. The objective of the researcher was to minimize the time used for the assembly.

4.5.3 Secondary data

All data used in a study is not necessarily collected for the study. This kind of data is called secondary data, which can consist of either raw data or published summaries. (Saunders, Lewis, & Thornhill, 2012, p. 304) Yin (2014) further divides secondary data into documentation and archive data. The secondary data used in this study were:

- Cost data from Enterprise Resource Planning -system (ERP)
- Distributor invoices
- E-mails
- Freight forwarder quotations
- Freight forwarder invoices
- Internal cost calculations
- Weekly reports from customer.

The advantage of secondary data is that most organizations collects and stores it, so it is available and doesn't consume time or money to collect like primary data. (Saunders, Lewis, & Thornhill, 2012, p. 304) The down side is that some type of secondary data can be inaccurate or contain bias. The researcher needs to be careful of which kind of data he uses. (Yin, 2014, p. 107) Another down side that needs to be kept in mind when using secondary data, is that it is always collected for another purpose, unlike primary data (Saunders, Lewis, & Thornhill, 2012, p. 318). For a case study, secondary data provides an important tool to validate findings from primary data. (Yin, 2014, p. 107)

Secondary data can be categorized in two groups: internal and external. The most important thing is to keep in mind that for which kind of situation the data was created for. (Saunders, Lewis, & Thornhill, 2012, p. 320) All the previously mentioned secondary data was internal, either qualitative or quantitative. In addition to those, some secondary data was collected from the internet, but the findings in that data was later validated from hard secondary data, like internal invoices, or by primary data.

4.5.4 Data collection and execution of the study

The first part of the study was to find the cost elements related to a portable crushing unit delivery. The elements needed to be found out thoroughly, because missing activities would add bias to the results. The mapping started with interviewing the key personnel. Finding the personnel for interviews was done with a snowball sampling strategy. The personnel interviewed were all internal and the data gained, saturated quickly. The personnel interviewed in the part were personnel from Sales Support or Order Office.

Once the cost elements were mapped, three portable crushing unit delivery cases were selected to be a part of the study. All delivery costs related to these cases were extracted from secondary data, such as invoices or ERP cost data, with a few exceptions. Even though secondary data was used, the acquisition of the data was time consuming. The data was collected from at least nine persons from seven countries. The secondary data gained, helped validating the cost element map, and some missing cost elements were even found in the process. Not all realized costs could be found from the secondary data available and those costs had to be estimated by an expert related to each matter. As an example, the terminal handling charges in an African country was estimated by a Metso entity in Africa. Some primary data was collected through observations. Case 3 was not a sunken case, as it was on going at the same time as the study. This gave the researcher a possibility to observe the time consumed for the assembly and commissioning phase of case. Also, the cost elements of the assembly, that were discovered from interviews, could be somewhat validated.

The second part of the study was to find the most suitable strategies for a portable crushing unit delivery in the terms of costs and risks. This part of the study was done mainly from by analyzing already collected data from the first part of the study. The costs for each of the three cases played an important role. Also, some internal interviews and two external interviews were made. The other external person interviewed was Metso's freight forwarder, and the other was the R&D manager of a partner company with a similar containerization process. The interview with the freight forwarder was mainly used to validate secondary data, and primary data gained from internal interviews.

5. RESULTS

This chapter represents the empirical part of the study. It presents the current cost structure of the delivery, compares the strategic choices for the best delivery and the risks included, and forms a process that can be used to price and control the delivery. Three different cases from two different market areas are selected for this study. The market areas Africa-Middle East & Turkey (AMET) and Commonwealth of Independent States (CIS). Even though there are two cases from AMET, the countries are from different continents and have few similarities. The costs of different cases are comparable, but instead of real currencies, symbol U is used to hide confidential cost information.

Case 1 was located in CIS and it was completed before the study was conducted. Case 2 was located in AMET and it was also a completed case. Case 3 was located also in AMET, and it was executed parallelly with the study. Due to external factors, the commissioning phase of case 3 was delayed and excluded from the study. The case still serves as the best case for comparing the two transportation methods, as both methods were used in the same case.

Figure 10 illustrates the material and information flow in a typical portable crushing plant delivery. The material is manufactured by the oversees factory in Asia and either sent to the distributor or straight to the customer. This depends on the nature of the case, whether the plant needs to be assembled in the destination country, and what is the best location for the assembly. The information flows also in a chain and is explained for the different cases in chapter 5.1.

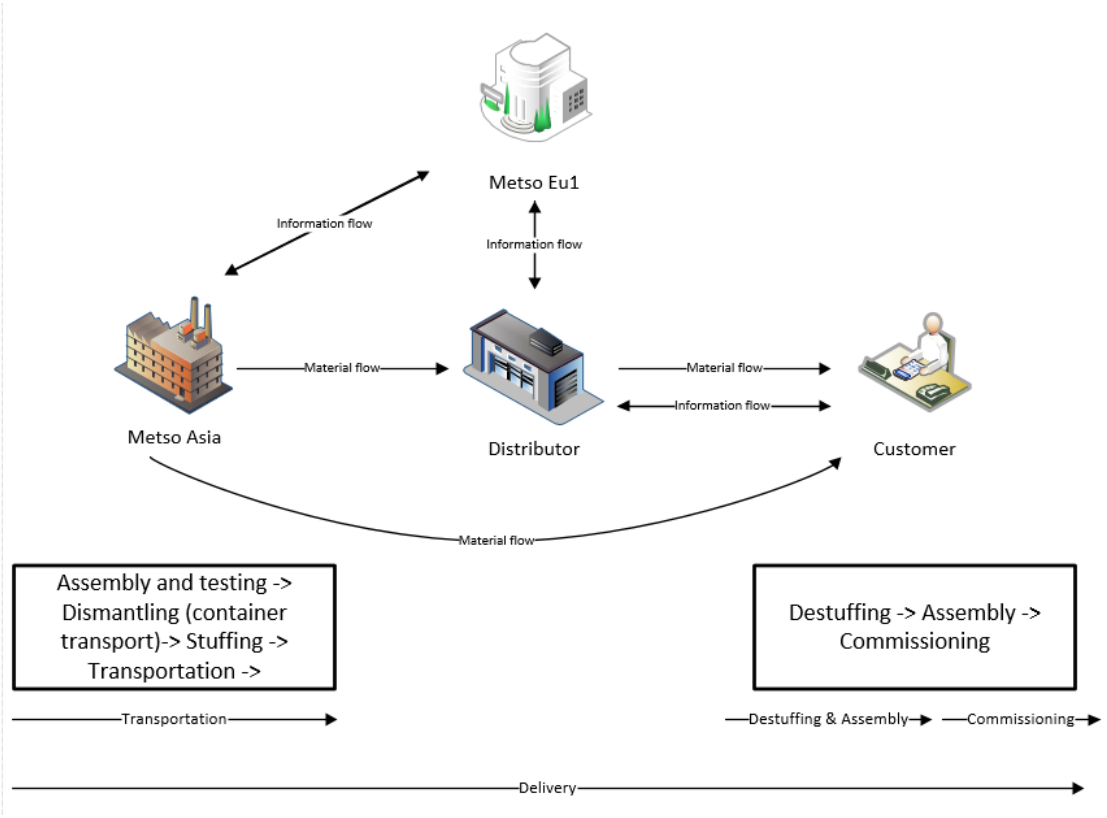

Figure 10. *Material and information flow between organizations*

The picture also illustrates the typical actions in a portable crushing plant delivery, and the straight arrows in the bottom part show the terms used in this study. Transportation and delivery can easily be mixed up, but in this study transportation is used up to the point where the plant reaches the customer, and delivery extends to the part where the plant is fully commissioned and crushing material.

5.1 Cost element mapping

The first objective when mapping the cost structure is to find out which organizations are involved in handling the delivery process. It is relevant to know which organization controls which costs, if the costs need to be improved. The organizations involved are shown in Figure 11.

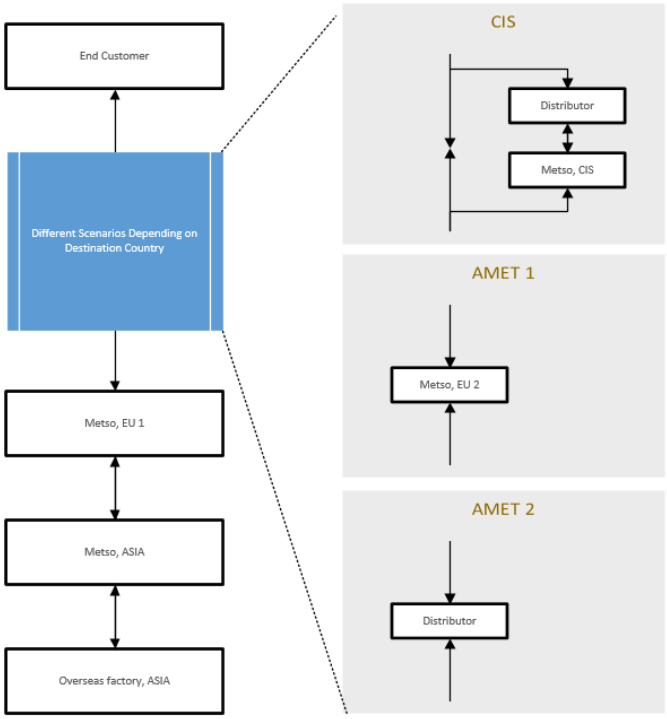

Figure 11. *Organizations involved in the delivery process*

In every case, there are at least five different organizations involved: the overseas factory, Metso Asia, Metso Eu 1, a distributor or a third Metso, and an end customer. The organizations involved depends on the country that the customer operates in. Metso Eu 1 is ultimately responsible for the delivery and handles the coordination of the whole process.

In the CIS-case, the sale of the plant was made directly to the customer, but there are also a distributor and a local Metso involved for two reasons: language and installation supervision of the plant. For AMET 1, there is Metso Eu 2 involved. The sale was made through Metso Eu 2 and they use the same language as the customer. For AMET 2, there is a distributor involved. The plant was sold to the distributor, who sold the plant to the end customer. Metso was still responsible for the supervision of installation and commissioning of the plant, but the distributor was responsible to get the required manpower and equipment to do the work.

The cost elements of a portable crushing unit delivery can be mapped by finding all the relevant activities that consumes resources and thus creates costs. Both, direct and indirect costs are considered. There are multiple purposes for the mapped cost structure. By studying the cost structure, it is possible to know how accurately Metso has estimated its costs and to know which organization is responsible for which costs. The costs structure can be also used to estimate what kind of costs distributors have, to make distributors more comfortable to deliver complex crushing plants to end customers. As the most

important purpose, it can be used to accurately price the delivery. A price too high can cost deals, and a price too low can eat up the profit margin.

Even though the study concentrates on the whole end part of the supply chain, the overhead costs of distributors and end customers are not considered in the costs structure. This differs from the view of supply chain costing, which thinks the supply chain as whole without company limits. Most overhead costs that would apply to distributors, are fixed costs and do not change when adopting Metso products to their scope. The variable overhead costs that can apply, are distributor specific and pointless to evaluate. It would also consume much time and effort.

The mapped cost elements of the transportation are shown in Appendix A. Even though there are different organizations involved in each case, the mapped cost structure could be constructed into a simplified structure where the destination market area consisted only of a distributor and an end customer. Surprisingly, there were few costs elements that would react with the economies of scale. In other words, if the scope of the delivery would double in size (double the crushing units), so would the costs.

The cost structure consists of all costs that are originated from the point where the units are fully assembled and tested. The cost structure consists of three parts: the transportation, destuffing and assembly and commissioning. The transportation is divided in two: Metso Asia and Metso Eu. In the present state, the costs structure of a portable crushing unit delivery, varies on the end customer's decision of should the plant be containerized or not. There are some limitations to the containerization as all the units are not yet a part of the concept that makes it possible to containerize the units. Also, there are some limitations to which countries Metso is willing to send the units containerized. The lack of proper installers, tools, or supervisors can make it impossible to assemble the units in the destination country.

5.1.1 Administration and capital costs

The overhead costs in this study, are administration costs from support activities and order handling activities. There are all together 11 relevant people involved in the three cases. In addition to these, there are other people who has put an insignificant amount of time in these cases, and they are calculated as a 10% contingency margin to the overall overhead costs.

The most relevant cost driver for every activity was time, as it was accurate and relatively easy to estimate. Often when allocating Order Office related costs, transaction-based drivers are used. The reason for time driven allocations was that the difficulty of each order varies a lot and thus the costs would not had been allocated correctly. Also, an intensity driver could have worked, but it seemed pointless. In large corporations like Metso, the cost of activities is usually driven from an ERP-system, in this case, SAP. All

relevant resources are pre-allocated to cost centers. Each cost center used in this study, has the total costs allocated and the total hours used by activities, from which an hourly rate can be calculated. The hourly rates and consumed hours is shown in Table 1.

Table 1. *Cost center prices and time consumed by each case*

	Hourly Cost	Case 1, CIS	Case 2, AMET 1	Case 3, AMET 2
Order Office Asia Manager	198,31 U/h	6 h	3 h	3 h
Order Office Asia Assistant Manager	92,82 U/h	12 h	8 h	8 h
Order Office Eu	161,44 U/h	45 h	75 h	60 h
Project Management Asia	144,69 U/h	45 h	51 h	53 h
Project Management Eu	380,54 U/h	0 h	0 h	42 h
Engineering Eu	236,93 U/h	7 h	1 h	48 h
Technical support Asia	147,32 U/h	14 h	1 h	0 h
Technical support Eu	211,46 U/h	32 h	2 h	25 h
Product Management Eu	476,92 U/h	50 h	20 h	52 h
Total		211 h	161 h	291 h

The hourly costs show that Product Management Eu and Project Management Eu is the costliest functions. Project Management Eu is relevant only in cases, which are somewhat exceptional and requires project management. These are so called C cases, in contrast with standardized A or B cases. For Metso Asia, all export cases are project cases, which means that a Project Manager is involved. The hourly costs also illustrate the differences between same functions in Eu or in Asia. The costs seem to be close to each other, but the Eu costs are usually a bit higher. Some of these functions are a necessity to have where there is production, but one might ask that should some functions be re-shored back to Eu. To assess the real cost-effectiveness, different kinds of drivers should be used, as the time-based driver does not assess the number of complete tasks.

The nature of the case seems to determinate the time required to use by different support functions. The units in Case 1 were fully containerized and the plant was assembled in challenging conditions, this case had the second most high overhead costs. The units in Case 2 were sent via RoRo and only the system portion required assembly. The overhead costs for this case were the lowest. Case 3 was an exceptional case with the need for constant supervision and it had the highest overhead costs. This finding illustrates that future pricing should consider the nature of the case, and the differences in the capabilities of the distributors and customers.

The overhead costs can be calculated from the hourly costs and used hours (Table 2). Order office costs were allocated to transportation and all support function costs were allocated either to destuffing and assembly or to commissioning, with two exception. Product management and project management time were used also for the transportation phase.

Table 2. *Overhead costs*

Asia transportation costs		Case 1, CIS	Case 2, AMET 1	Case 3, AMET 2
Order Office Asia Manager		1 189,84 U	594,92 U	594,92 U
Order Office Asia Assistant Manager		1 113,87 U	742,58 U	742,58 U
Project Manager		3 617,19 U	4 485,32 U	4 774,69 U
Contingency 10%		592,09 U	582,28 U	611,22 U
Total		6 512,99 U	6 405,10 U	6 723,41 U
EU transportation costs				
Engineerin Eu		236,93 U	0,00 U	3 790,81 U
Order Office Eu		7 264,82 U	12 108,04 U	9 686,43 U
Product Management Eu		12 399,90 U	7 153,79 U	12 399,90 U
Project Management Eu		0,00 U	0,00 U	5 137,31 U
Contingency 10%		1 990,16 U	1 926,18 U	2 587,71 U
Total		21 891,81 U	21 188,01 U	33 602,16 U
Destuffing and assembly				
Engineering Eu		236,93 U	0,00 U	0,00 U
Product Management Eu		0,00 U	0,00 U	12 399,90 U
Project Management Eu		0,00 U	0,00 U	13 318,96 U
Technical support Asia		1 178,54 U	0,00 U	0,00 U
Technical support Eu		422,91 U	0,00 U	5 286,39 U
Contingency 10%		183,84 U	0,00 U	3 100,52 U
Total		2 022,21 U	0,00 U	34 105,77 U
Plant commissioning				
Engineering Eu		1 184,63 U	236,93 U	
Project Management Asia		2 893,75 U	2 893,75 U	
Technical support Asia		883,91 U	147,32 U	
Technical support Eu		6 343,66 U	422,91 U	
Product Management Eu		11 446,06 U	2 384,60 U	
Contingency 10%		2 275,20 U	608,55 U	
Total		25 027,21 U	6 694,05 U	
Total		**55 454,22 U**	**34 287,16 U**	**74 431,34 U**

The overall overhead costs of the different cases seem to align with the hours used. The Asia transportation costs for each case seem to be approximately the same. This is due to the same tasks with the same complexity. For the Eu transportation costs, Case 1 and Case 2 had almost the same costs, but Case 3 had roughly one third higher costs. This is due to the complexity of the case and the require for more support. For the destuffing and assembly phase Case 1 had some overhead costs and Case 2 had none. This is where the complexity of Case 3 is highlighted. For the commissioning phase Case1 had more overhead costs than Case 2, even though they should be roughly the same. The reason for the difference was unexpected difficulties that can realize randomly, in other words, bad luck.

The capital costs in this study are the costs that are created from tied up capital in each transportation. The capital is tied up between the time that a supplier has been paid and the time that Metso receives payment from the customer. The cost of capital was calculated only for the transportation phase of the delivery, as it was possible to calculate a specific date when the transportation was paid. In the assembly and commissioning phase, it is impossible to figure out the dates when capital is used for each activity. The weighted average cost of capital (WACC) for Metso Minerals was 12,1 % in 2016 (Metso Corporation, 2016, p. 42).

The process of calculating the capital costs started by finding out all costs and dates that are related to the transportation. The second step was to calculate the weighted average date of cost. This was done by using a reference date which can be any date before the actual cost dates. The third step was to calculate the days between the reference date and the actual cost dates. The days were weighted with the cost amounts. After this the weighted average date was calculated by adding the weighted average days to the reference date. The equation for the weighted average days from the reference date can be calculated with the following equation:

$$D_{\mathrm{wavg}} = \frac{\sum_{i=1}^{n}(D_{\mathrm{ref}_n} \cdot V_n)}{\sum_{i=1}^{n}(V_n)}, \tag{1}$$

where D_{ref} denotes the days from the reference date, V denotes the value of the transaction (costs) and n denotes the number of transactions. This process was also used for calculating the weighted average date for customer payments. An example of these calculations is illustrated in Table 3. The real calculations are not shown for the protection of Metso and the real calculations contained hundreds of rows of excel data.

Table 3. *Cost of capital calculations (example)*

Costs					
Cost element descr.	Val.in rep.cur.	Posting Date	Reference date	Days	Weighted days
Factory Output COGS	3 378,88	30.7.2016	1.7.2016	29,00	97988
Freight of sales	47,72	24.10.2016	1.7.2016	115,00	5488
Packing costs	3 135,89	24.10.2016	1.7.2016	115,00	360627
Sum	6 562,49				464103
	Weighted average days		Weighted average date		
	70,72		10.9.2016		
Revenues					
Cost element descr.	Val.in rep.cur.	Posting Date	Reference date	Days	Weighted days
Payment	621 034,00	24.11.2016	1.11.2016	23	14283782
Payment	500 000,00	7.12.2016	1.11.2016	36	18000000
Sum	1 121 034,00				32283782
	Weighted average days		Weighted average date		
	28,80		30.11.2016		
	Costs date	Revenues date	Days	Wacc	Cost of capital
	10.9.2016	30.11.2016	81	12,10 %	176,22

Once both dates were calculated, it was possible to calculate the days between these dates and derive the capital costs. The capital costs were calculated with the following equation:

$$C_{\text{capital}} = \frac{\text{WACC}}{365 \cdot D_{\text{bref}} \cdot C_{\text{tot}}}, \quad (2)$$

where D_{bref} denotes the days between the reference dates and $C_{\text{tot}} = \sum_{i=1}^{n}(V_n)$ denotes the total costs. The cost of capital for all the three cases are shown in Table 4.

Table 4. Cost of capital

Cost of Capital	Case 1, CIS	Case 2, AMET	Case 3, AMET 2
Asia transportation costs	1 170,16 U	-6 104,69 U	2 406,19 U
Eu transportation costs	-11 927,79 U	-8 191,72 U	244,18 U
Total	-10 757,63 U	-14 296,41 U	2 650,37 U

Depending on the payment dates for each case, the costs can be positive (costs) or negative (revenue). Case 1 and Case 2 had a total of negative costs meaning that it was beneficial for Metso. The benefit or loss in the capital is relatively small and it should not be used as a variable in the pricing process.

5.1.2 Case 1, CIS

The scope of the first case was to deliver a plant of five crushing units to the end customer. The delivery of this plant was sold in containers, all together 27 containers, of which 11 was the system portion. The plant was divided into two parts, the first containing two units, the second containing three. The plant was also shipped in the same two parts. This was a unique case, as some exceptions were made due to commercial reasons. Therefore, the case had some adjustments in policies and some of the charges to the end customer was overlooked. The results are presented in a way that the case would have gone without the overlooked charges.

The end customer destuffing and assembly costs are estimated from weekly reports that are made by the end customer. All together the destuffing and assembly took 54 work days. Metso paid for their own engineers and the distributor engineers, and the end customer paid for its own costs. The times and rates used to calculate the end customer costs are listed in Table 5.

Table 5. *Hours and rates for case 1*

	End Customer installers	End Customer engineers	Metso/Distributor engineers	Cranes
Destuffing & Assembly	2 616 h	402 h	677 h	62 d
Commissioning	504 h	78 h	597 h	5 d
	Installer rate	Engineer rate	Metso/Distributor engineer rate	Crane rate
	28 U/h	85 U/h	338 U/h	1 948 U/d

The delivery costs start running from the dismantling and packing in the factory, and stop when all parts have reached their destination, and the plant has been assembled and commissioned. In this case the inland transportation from the destination port is also included to Metso's scope. Table 6 shows the costs for case 1.

Table 6. *Costs for case 1, CIS*

Case 1, CIS			
Asia transportation costs	**Cost for the complete delivery**	**Cost for a single unit (container)**	**Cost for a single unit (simulated RoRo)**
Dismantle	48 928 U	9 786 U	0 U
Packaging material	84 465 U	9 385 U	0 U
Stuffing	38 961 U	4 329 U	0 U
Transportation to port	92 078 U	10 231 U	17 261 U
Port & Customs Clearance	54 937 U	6 104 U	4 231 U
Indirect costs	6 513 U	724 U	724 U
Cost of Capital	1 170 U	146 U	80 U
Sub total	327 053 U	40 704 U	22 016 U
EU transportation costs			
SOC purchase in Port	252 599 U	28 067 U	0 U
SOC survey charges	5 871 U	652 U	0 U
Empty containers to factory	151 659 U	16 851 U	0 U
Ocean freight	231 430 U	25 714 U	187 594 U
Terminal handling charges	48 615 U	5 402 U	0 U
Trucking to endcustomer	147 738 U	16 415 U	0 U
Truck Demurrage costs	36 579 U	0 U	0 U
Indirect costs	21 892 U	2 432 U	2 432 U
Cost of Capital	-11 928 U	-1 271 U	-2 529 U
Sub total	884 454 U	94 262 U	187 497 U
Destuffing and assembly			
End Customer Cranes	120 776 U	18 311 U	0 U
End Customer Worker Labor	74 069 U	10 963 U	0 U
End Customer Engineers	34 186 U	5 060 U	0 U
Distributor Engineers	270 169 U	39 988 U	0 U
Indirect costs	2 022 U	225 U	0 U
Sub total	501 223 U	74 547 U	0 U
Plant commissioning			
End Customer Cranes	9 740 U	1 948 U	1 948 U
End Customer Worker Labor	14 270 U	2 854 U	2 854 U
End Customer Engineer	6 586 U	1 317 U	1 317 U
Metso / Distributor Engineer	160 215 U	32 043 U	32 043 U
Indirect costs	25 027 U	2 781 U	2 781 U
Sub total	215 838 U	40 943 U	40 943 U
Total	**1 928 568 U**	**250 457 U**	**250 457 U**

The cost for a single crushing unit was calculated from the overall costs. The documents from the end customer reveal how much time was used on the system portion, and how much time was used for the units. This made possible an accurate calculation of the destuffing and assembly costs for a single unit. There is also a cost estimation for the transportation of a single unit via RoRo. The costs in the RoRo column that are marked in black are the estimated costs. Metso's freight forwarder had trouble finding a RoRo route to the target location. In fact, the route was not found in time to be a part of this study and the reason behind it was the geographic location of the destination country. The cost that is marked in red in the RoRo column, is the break-even cost for the hypothetical RoRo route. Also, the salvage value for the used SOCs should be considered as an asset when comparing the two methods.

The overall costs of the case are shown in Figure 12. The bottom bar illustrates the costs originated by each organization in the supply chain and shows that most of the costs are controlled by Metso.

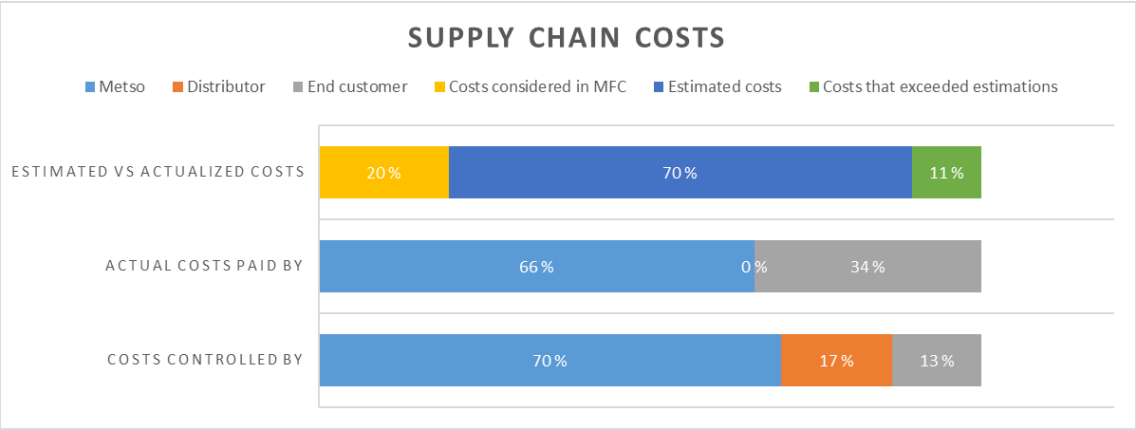

Figure 12. *Supply chain costs for case 1.*

The middle bar illustrates the amount of costs that were paid by each organization. Metso paid for the distributor's costs and charged the end customer for 21 % of the overall costs, which resulted in the situation in the middle bar. The top bar illustrates the cost estimations by Metso. The costs that were controlled by Metso Asia, were considered in the MFC (manufacturing cost) of Metso Europe. The costs for Metso Europe were estimated 11 % less than they were. Approximately 1 % of the excess was due to the overhead and capital costs that were not considered in the estimations. Roughly, the rests were due to technical difficulties in the assembly and commissioning phases.

5.1.3 Case 2, AMET 1

The scope for the second case consists of four crushing units. All four units were transported via RoRo, and the system portion was shipped in 12 containers. For this case, there is no Distributor involved. The plant was sold through Metso Eu 2, and the costs for the transportation are divided by Metso Asia and Metso Eu 2.

As all the units were sent via RoRo, there was no need to assemble them. The only thing that needed assembly was the system portion. The assembly of the system portion and commissioning were done with an average of 5 installers. The system portion was assembled in 24 work days and the plant commissioning was done in 18 days after that. The hours and rates used to calculate the end customer and Metso costs, are listed in Table 7.

Table 7. *Hours and rates for case 2*

	End Customer installers	End Customer engineers	Metso engineers	Cranes
Destuffing & Assembly	1 920 h	384 h	384 h	48 d
Commissioning	1 440 h	288 h	288 h	36 d
	Installer rate	Engineer rate	Metso engineer rate	Crane rate
	5 U/h	283 U/h	487 U/h	974 U/d

The scope of the transportation for Metso was to deliver the plant to the port of discharge and pay for the freight. The rest of the transportation was handled by the customer itself. The costs for case 2 is shown in Table 8.

Table 8. *Costs for case 2, AMET 1*

Case 2, AMET 1			
Asia transportation costs	**Cost for the complete delivery**	**Cost for a single unit (RoRo)**	**Cost for a single unit (simulated container)**
Dismantle	6 966 U	1 741 U	9 740 U
Packaging material	51 646 U	0 U	12 912 U
Stuffing	3 741 U	0 U	935 U
Empty containers to factory	59 454 U	0 U	14 864 U
Transportation to port	101 149 U	15 256 U	10 032 U
Port & Customs Clearance	64 778 U	4 326 U	11 868 U
Indirect costs	6 405 U	801 U	801 U
Cost of Capital	-6 105 U	-459 U	-1 269 U
Sub total	288 035 U	21 665 U	59 882 U
EU transportation costs			
Ocean freight	599 303 U	127 485 U	22 341 U
Indirect costs	21 188 U	2 649 U	2 649 U
Cost of Capital	-8 192 U	-1 718 U	-330 U
Sub total	612 299 U	128 415 U	24 659 U
Customer transportation costs			
Terminal handling charges	85 712 U	6 818 U	14 610 U
Trucking to site	126 620 U	24 350 U	7 305 U
Container return	26 298 U	0 U	6 575 U
Sub total	238 630 U	31 168 U	28 490 U
Destuffing and assembly	(system portion)		
End Customer Cranes	46 752 U	0 U	11 688 U
End Customer Worker Labor	9 740 U	0 U	2 435 U
End Customer Engineer	97 400 U	0 U	24 350 U
Metso Engineer	211 358 U	0 U	52 840 U
Indirect costs	0 U	0 U	0 U
Sub total	365 250 U	0 U	91 313 U
Plant commissioning			
End Customer Cranes	35 064 U	8 766 U	8 766 U
End Customer Worker Labor	7 305 U	1 826 U	1 826 U
End Customer Engineering	73 050 U	18 263 U	18 263 U
Metso Engineer	164 606 U	41 152 U	41 152 U
Indirect costs	6 694 U	837 U	837 U
Sub total	286 719 U	70 843 U	70 843 U
Total	**1 790 933 U**	**252 091 U**	**275 186 U**

The costs for a single unit was calculated from the overall costs. Since the units did not need to be assembled, it was much easier to calculate the cost for a single unit. There was no need to analyze weekly reports as the whole destuffing and assembly stage was for the system portion.

The costs for a single unit delivered in containers were estimated from the container prices for the system portion and from the other cases. The ideal time for assembling four containerized units is four weeks, and these estimations was used in the calculations of Table 8. The calculations show that even with the ideal time the containerized option would have been more expensive than the RoRo. The calculations can be even further speculated. If an increase of 5 workers would shorten the assembly time by a week, then the results would be as shown in Table 9.

Table 9. *The effect of increasing the labor*

Actual costs for 5 installers and 3 weeks		
Destuffing and assembly	Cost for the complete delivery	Cost for a single unit (Container)
End Customer Cranes	46 752 U	11 688 U
End Customer Worker Labor	9 740 U	2 435 U
End Customer Supervisor	97 400 U	24 350 U
Metso Engineer	211 358 U	52 840 U
Sub total	365 250 U	91 313 U
Simulation for 10 installers and 3 weeks		
Destuffing and assembly	Cost for the complete delivery	Cost for a single unit (Container)
End Customer Cranes	35 064 U	8 766 U
End Customer Worker Labor	14 610 U	3 653 U
End Customer Supervisor	73 050 U	18 263 U
Metso Engineer	164 606 U	41 152 U
Sub total	287 330 U	71 833 U

The cost for the assembly of a single containerized unit would be roughly 20 000 U less, but even this optimistic drop in the costs would not make the containerized option less expensive than the RoRo option. The methods would almost reach a parity and usually RoRo would still be the less troublesome option. The only scenario where same priced containerized delivery should be used over RoRo, is when the availability of a RoRo delivery would be extremely poor.

Figure 13 shows the supply chain costs for case 2. Unfortunately, the cost estimations that were made prior to the case are not available, and the budgeted vs. actualized costs cannot be compared.

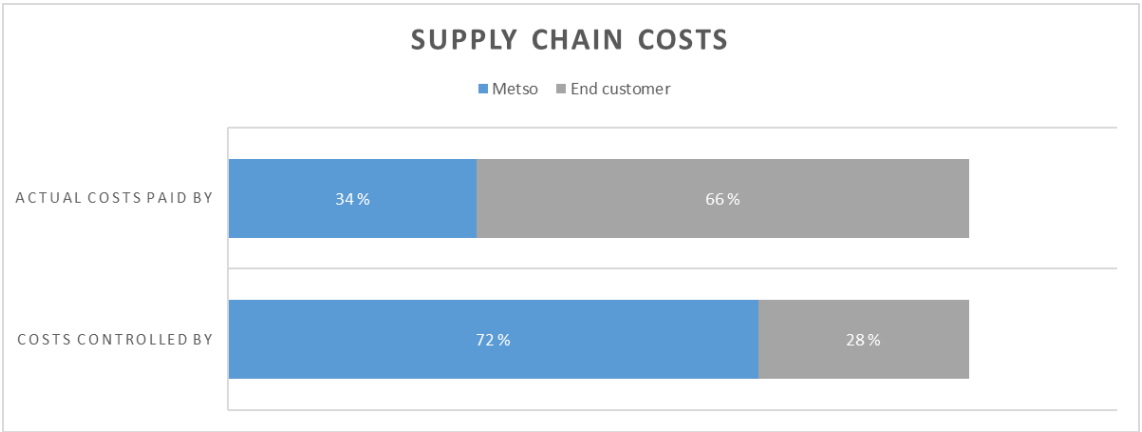

Figure 13. *Supply chain costs for case 2*

Metso controlled 72 % of the overall costs and charged the customer for 38 %. Metso was left with 34 % of the overall costs.

5.1.4 Case 3, AMET 2

The last case is a good reference case for this study. The first reason for this is that the author of this study was also the Project Manager for this case and knows precisely all the things that happened. The second reason for this is the nature of the case. There are units that are sent containerized and via RoRo. This eliminates the need for estimating the other transportation method and thus gives genuine and exact results.

The scope of the third case is three crushing units and a screening unit. All crushers were sent from Europe, and mainly other parts from Asia. One of the units was send in three containers and one fully assembled via RoRo. The system portion was sent in 11 containers. The chassis of two units were send via roro, but the crushers of these units were send containerized. The unusual solution to send parts from Europe and Asia brought some challenges to the calculations. Luckily there were one unit that was sent fully containerized and one unit sent fully assembled. Also, the destination country has an import tax for crushers and screens that are imported from the country that Metso's overseas factory is located in. This brought another new element to the case.

There is a distributor involved in the case and the units were assembled at the distributor's site. After that the plant should be transported to the end customers site, but unfortunately it did not happen in the required time frame to be a part of this study. The assembly took all together 25 days. The hours and rates are shown in Table 10. The distributor provided only the overall costs of its part of the assembly. The distributor rates and crane rates are estimated, but the distributor hours are observed by the author and a few of his colleagues. Also, the Metso rates are actualized.

Table 10. *Hours and rates for case 3*

	Distributor installers	Distributor supervisor	Metso engineers	Cranes
Destuffing & Assembly	1 008 h	144 h	344 h	32 d
Commissioning				
	Installer rate	Supervisor rate	Metso engineer rate	Crane rate
	146 U/h	244 U/h	390 U/h	1 911 U/d

For this case the scope for Metso was to transport the plant to the port of discharge. The distributor paid for the freight and the rest of the transportation after that, with one exception. Metso paid for the air freight of one backorder. This was not included in the calculation for different methods, as it is not a cost that occurs regularly. The delivery costs for case 3 is shown in Table 11.

Table 11. *Costs for Case 3, AMET 2*

Case 3, AMET 2			
Asia transportation costs	**Cost for the complete delivery**	**Cost for a single unit (Container)**	**Cost for a single unit (Roro)**
Dismantle			
Packaging material	47 048 U	6 625 U	0 U
Stuffing	4 833 U	1 669 U	0 U
Empty containers to factory	38 443 U	10 484 U	0 U
Transportation to port	95 031 U	10 153 U	19 267 U
Port & Customs Clearance	22 574 U	2 773 U	4 135 U
Indirect costs	6 723 U	1 009 U	1 009 U
Cost of Capital	11 718 U	1 786 U	1 333 U
Sub total	226 371 U	34 500 U	25 744 U
EU transportation costs			
Air freight	28 245 U	0 U	0 U
Indirect costs	33 602 U	5 040 U	5 040 U
Cost of Capital	1 189 U	97 U	97 U
Sub total	63 037 U	5 137 U	5 137 U
Distributor transportation costs			
Ocean freight	883 433 U	80 928 U	241 638 U
THC	58 416 U	19 467 U	3 187 U
Import tax	71 501 U	4 091 U	22 470 U
Trucking to site	46 265 U	3 385 U	11 284 U
Container return	11 171 U	3 047 U	0 U
Sub total	1 070 786 U	110 918 U	278 579 U
Destuffing and assembly			
Distributor costs	243 500 U	42 613 U	
Metso Engineer	134 281 U	40 134 U	
Indirect costs	34 106 U	5 116 U	
Sub total	411 887 U	87 862 U	
Total	1 772 081 U	238 418 U	309 460 U

The costs for single units with both transportation methods were calculated from the overall costs. The difference between the costs is significant. The difference is mostly due to the cost difference in the freight, which makes the containerized method significantly less costly. The other factor that slightly affects the costs, is that the containerized unit did not need to be disassembled in the overseas factory, as it could not be fully assembled and tested without a crusher.

Figure 14 shows the supply chain costs for case 3. As the distributor handled the transportation from the port of origin, there are no delivery costs charged from the distributor. This means that most of the delivery costs are controlled by the distributor. Also, the possible risks or rewards will be realized for the distributor only.

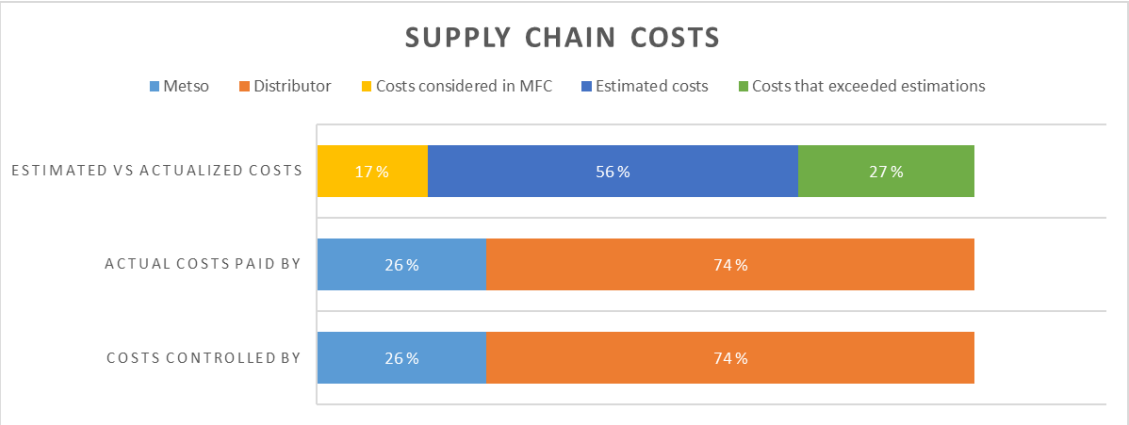

Figure 14. *Supply chain costs for case 3*

If looking at the estimated vs. actualized costs, the costs that exceeded estimations seem to be 27%. This would be a significant error, but there is an explanation for it. Metso offered to handle the transportation of the plant to the destination port, but the distributor wanted to take care of the transportation itself. As result the distributor ended up paying significantly more than what it would have paid if Metso would have taken care of the transportation. It seems that Metso has competitive prices for its transportations. If the case would have been executed with Metso's prices, the costs would had exceeded estimations by 11 %. The 11 % excess is due to miss estimations in all parts of the delivery.

5.1.5 Findings

Cost element mapping can be used to find out the structure of the relevant costs. The structure can be used in the pricing and controlling process. Cost element mapping can also be used to make sensitivity analyses and compare different scenarios. The pricing process should include at least a sensitivity analysis that compares both methods of transportation. Based on the sensitivity analysis, it is possible to pick the right option, in the terms of costs. Other risks than cost risks should be evaluated in a qualitative way.

Cost element mapping can also be used to find out the performance of each partner in the supply chain. By mapping the costs for different cases, it is relatively easy to compare different partners and evaluate their performance. It can also be used to see how new costs or benefits are divided throughout the supply chain.

The overhead costs of the deliveries are highly dependent on the difficulty of case and the experience of the distributor and/or end customer. The costs seem to be otherwise fixed, as the scale of the delivery affects little to the overhead costs. This should be considered in the process. Small cost savings can be achieved from billing customers before the delivery has started. All cost savings should be pursued, but the cost savings from the cost of capital should be assessed with the lowest priority. It should be

highlighted, that the capital that is tied up in the value of the plant, is not evaluated. Just the capital that is tied up in the transportation costs.

Case 1 and case 3 show that the budgeted costs in that case were not completely accurate and there is a need for a better process of pricing the delivery. Inaccurate pricing can cause problems in the margin of a project or the delivery can be overpriced, which can lead into losing a contract to competitors. With cost element mapping, managers can find out the actualized costs of a project, and furthermore, find them out precisely. The actualized costs can be compared to the budgeted costs. This illustrates that one benefit that can be driven from cost element mapping is to find out which projects are causing problems.

Case 3 showed that how significant costs can be realized, if some activities are performed by the wrong organizations in the supply chain. The realized costs did not affect Metso, but it is not good for future business. It seems that Metso has competitive prices in freights, as it is relatively larger than its distributors.

5.2 Delivery strategy

This part of the study aims to find out, what kind of strategies are suitable for delivering the crushing plants. The criteria for the best strategy should consider costs and delivery time as first priority. Second priority criteria should be quality risks, technological risks and risk of damages. There are multiple factors that affects these, including the destination country, how skilled labor is available, the availability of container / RoRo ships, the value of the plant and the physical dimensions of the units. The most important decision-making factors are assessed in this sub chapter.

5.2.1 Import duty

Import duty is a small factor that can cause huge effects in the profitability of the projects. Luckily Metso's delivery terms are excluding taxes and duties, so they do not increase Metso's risk portfolio, but it may have significant effects to distributors and customers. Countries can use tariffs to tax imports coming from certain countries. Most governments have lists of their import duties on the internet, and finding them out are relatively easy. If there is a project where import duties are relevant, the case should be assessed with proper finesse. These kinds of calculations include the value of the equipment and extend over the reach of this study.

5.2.2 Maritime transportation

One of the objectives in this study is to compare two ways of shipping the crushing units: containerized or fully assembled via RoRo. A RoRo freight is usually always more expensive than a container freight. The question is: can the cost savings from the container

freight exceed the losses from the disassembly and re-assembly. The cost saving does not necessarily realize from the first containerized delivery as the delivery is usually hard to execute with no former experience.

In comparison to costs, ship availability is an important factor as well. When choosing the right method and the right ship, it should be noticed that what will happen if the departure date is missed and how likely that will happen. A possible scenario is that the departure date will be missed by a day, but the delivery will be delayed a month, because no substitutive ship is available earlier. This can also generate costs from detention and demurrage, when the cargo is stored in the port. A proper risk analysis is always needed, before selecting the ship.

Both methods have pros and cons, which makes it difficult to find the best solution. Based on the interview with Metso's freight forwarder, RoRo ships has gotten more competitive against container ships in the past year. There seems to be a rising trend in the demand of container freights, which is raising prices and weakening the availability to ship containers. Adding to this, there was a recent default in a large shipping company. Also, shipping companies have invested in new RoRo ships, which decreases the cost of RoRo freights and has led to a more frequent RoRo traffic. RoRo availability has increased from once every four weeks to once every two weeks, for the intercontinental RoRo routes.

The red line is that neither of these methods can be excluded when considering the right method. For different situations either one can be the right choice in terms of costs and risks.

5.2.3 Shipping containers

Potential cost savings in containerized transportations could be made, if the container transportations would be handled with carrier owned containers (COCs). Sadly, this is not possible or reasonable for some cases. COCs are rental containers that will generate detention or demurrage costs, if not handled in a proper way. Detention charges occur when the containers have been collected from the port and the so called free time has expired. The free time is usually around ten work days. Demurrage costs will occur when the COCs are standing at the port. For demurrage, the free time is usually from 5 to 7 work days. If the freight is cancelled, the so called "free time" stops existing and the penalties start running from day one.

The other option in containerized deliveries is to use shipper owned containers (SOCs). SOCs are usually purchased from the port of origin and costs a significant amount of money. In case 1, the SOCs increased Eu transportation costs by 29 % and overall costs by 13 %. SOCs are used for various reasons. If COCs are late, the carrier will collect detention or demurrage costs. The cost for late containers are to be taken seriously, as the costs for a whole containerized plant is tens of thousands of dollars per month, which can

quickly leech out the profit margin of a project. Also, for some exotic locations it would be cheaper to just leave the SOCs there than it would be to transport COCs back to the point of origin. Some shipping companies do not accept SOCs, this applies usually to the routes to Africa. On the other hand, to places like the CIS-countries, SOCs are usually the only possibility.

SOCs are costly, but they can be resold or utilized to other use, which means that they have value after the delivery, and some of the costs can be reimbursed after the delivery. The real risk lies in COCs, and when they are used in the proper way. Based on the invoices of former deliveries, detention charges can increase the ocean freight costs by 8 % per day. The usage of SOCs should be favored in situations where is even a small possibility that detention or demurrage costs will occur. A risky point for detention costs is if COCs are transported to the overseas factory, even though the customer has not paid for the plant or a letter of credit (LC) has not been made. Metso's manufacturing plant cannot ship the containers without receiving the full amount for the plant, or without a sustainable relationship with the customer. A risky point for demurrage costs is when the plant has been shipped, and the distributor is not certain where to transport the plant. This can be in cases where the end customer has not paid the distributor and an LC has not been made. This prevents the distributor from delivering the plant to the customer.

The bottom line in SOCs and COCs is that both types are essential in some cases and the usage of either one cannot be excluded. The usage of COCs are riskier, but might provide cost savings. A proper risk assessment is required when operating with COCs. This can be handled with contract management: mitigating, eliminating or transferring the risks.

5.2.4 Used labor

As two cases of this study was conducted in low cost countries, the labor used in the assembly and commissioning phases were significantly less expensive than the prices of the Western engineers. Therefore, the manpower used should have been maximized, as long as it decreases assembly and commissioning times.

Case 2 had the largest contrast between the prices of installers and engineers. Table 12 illustrates the effects of doubling the manpower, if it would cut down the duration of assembly of the system portion by one week and reduce costs of the assembly.

Table 12. *The effect of labor in Case 2*

Destuffing and assembly	5 installers 4 weeks	10 installers 3 weeks (simulation)
End Customer Cranes	46 752 U	35 064 U
End Customer Worker Labor	9 740 U	14 610 U
End Customer Supervisor	97 400 U	73 050 U
Metso Engineer	211 358 U	164 606 U
Sub total	365 250 U	287 330 U

By doubling the labor for a shortened period of time, the labor costs would go up, but the total amount would be significantly reduced. Although, it is not a fact that increasing the manpower would suppress the duration. There is a possibility that the location does not have the room for parallelly assemble multiple units and thus only five installers can be used simultaneously. It can be concluded that a most suitable location would be one with enough space to do multiple units parallelly.

5.2.5 Strategic choices and risks involved

The strategic choices (columns) and the risks (rows) involved can be illustrated in a matrix (Table 13). Even though RoRo vs. containerized and complete vs. dismantled are practically the same strategic choice, they are examined in separate columns. This is due to different risks in different parts of the delivery. RoRo vs. containerized represents the transportation part of the choice, and complete vs dismantled represents the assembly part.

Table 13. *Risks involved in the strategic choices*

	RoRo vs. Containerized	SOC vs. COC	Complete vs. Dismantled
Cost risk	x	x	x
Delivery time risk	x	x	x
Quality risk			x
Technological risk			x
Risk of damages	x		

Cost risks and delivery time risks are involved in all the strategic choices. These two risks are the most important ones and should be prioritized in the delivery process. The other risks should be assessed with a secondary priority.

5.2.6 Findings

The best strategy for the delivery should be based on cost and delivery time. One possible way of executing the best strategy is to set an acceptable delivery time with a contingency margin, and then minimize the costs used to carry out the delivery time. Quality risk, technological risk and risk of damages should be assessed as well, but with a lesser priority. According to the findings from chapter 5.1, both methods of transportation should be

considered (containerized and RoRo). For situations where there is a possibility of consecutive deliveries, containerized plants can provide cost savings in the future, even if the first delivery would be more expensive than a RoRo delivery. The future savings can be derived from the experience in the assembly phase.

If the method of transportation is containerized, COCs should be used by default. If for any reason SOCs might be required, the proper assessment is required. The usage of SOCs can be prompted for two different reasons. The location might require the usage of SOCs, or there is an uncertainty with the customer. If the desire of using SOCs are derived from the uncertainty that the customer will have financial issues, and the customer is not willing to buy the containers, there are two ways of mitigating or eliminating the risks. Either to receive full payment from the customer before the COCs are purchased, or to form a LC. A LC is issued by the buyer's bank, and obligates the bank to reimburse the payment, if the buyer cannot make its dues.

In containerized transportations, there is an assembly phase. There are multiple ways of conducting the assembly, but usually only one method is available due to the available facilities of the parties involved. If there are multiple options like doing the assembly in the distributor's work shop, or at the end customer's site, the better choice should be the less costly one, if there is still sufficient time to deliver the plant on time. Doing the assembly in a work shop can provide cost savings from rental machinery such as cranes or forklifts. It can also save time used in the assembly, which can reduce the costs from manpower as well as the costs from supervision. Another important factor in the assembly stage is the manpower used for the assembly. As previous calculations show, in low cost countries, the hired manpower correlates little with the overall costs of the delivery. Most costs are generated by the supervision of the project, and thus manpower used should be maximized.

5.3 Delivery handling process

The delivery handling process was created to price and control the delivery in the best way. The process is shown in Appendix B. There is only one decision making point that alternates the path used in the process. This decision is made based on the seriousness of the customer's inquiry. If the customer is serous and the deal is likely to happen, then a formal quotation should be given for the plant. In contrast, if the customer is checking the prices for a possible deal in the far future, the costs should be estimated using historical prices.

The cost estimation should be calculated with the excel template that was created for this purpose. The excel template provides Sales Support Managers with an accurate cost estimation for the transportation, assembly and commissioning. The template requires freight prices as an input. The freight prices can be either historic prices or the real checked prices, depending on the probability of the deal (the decision-making point). The historic prices should be checked from a list that is provided by Metso's freight forwarder and should be updated after each quotation. The analysis made from the overhead costs

of the cases, determinates that the overhead costs in the delivery should be considered from the difficultness of the case and the experience of the distributor and/or customer.

Quotation review, order review and assembly review are the most important points in the process and highlighted in orange. The quotation review is a point where all relevant departments of Metso should decide whether the used strategy for the transportation is correct. In situation where the delivery is somewhat standard, the quotation review can be made by a single person. The quotation review is the point where all terms and conditions are locked and cannot be changed afterwards. Metso Distributor Business Managers should be a part of the review and coordinate information with the distributor. The order review is a point where the order should be check for possible mistakes, and that the terms and conditions were understood mutually by all parties. The assembly review should be done before starting the assembly. This should include all parties that are going to be a part in the assembly. The point of the review is to ensure a flawless assembly, which usually can be achieved when the required support documents are updated and available.

In the assembly and commissioning phase, the supervisor should always write a report with a description of what has been done in detail. This will enable the possibility to measure the success of the delivery. The report should contain both financial and non-financial data, and be at least detailed enough, to separate the work done for each unit and the system portion. It also should also separate the assembly phase and commissioning phase. The written report gives an understanding of what has happened, and the financial part gives an understanding of how well the project performed financially. Combining financial and non-financial elements gives a balanced understanding of the situation. As there was a report available in case 1 and case 3, it was relatively easy to get a picture of what had happened in these cases. In case 2, there was no written report, making it impossible for the researcher to interpret the occurred situation, and to decide whether the project was a success or were there parts that could be handled better. The case 2 costs were estimated from the information that the supervisor gave subsequently.

The point of the process is to ensure that a project manager should not be needed, instead the information and material should flow successfully between the relevant departments without any supervision. Yet, it would be beneficial to have a manager to oversee the portable deliveries from quotation to commissioning. No process can be implemented instantly, meaning that there is a need for supervision. One way of putting it is that the project manager should try to make himself jobless. Each department should do sub-optimization in the parts that are relevant for them, but the project manager should be responsible for optimizing the whole delivery.

5.4 Summary

The main research problem can be answered based on the three sub problems, thus the sub problems are addressed first in this summary.

The first sub problem was:

1. **What kind of benefits can be driven from mapping the cost elements of the delivery?**

Cost element mapping can be used to find out the cost structure and the most common variables of a portable delivery. As the cost structure and variables are known, it is possible to do sensitivity analyses as LaLonde & Pohlen (1996) suggested. The sensitivity analyses can be used to find the best variables to conduct the delivery. From the customer's point of view, this means either a more competitive offer, or a reduced process time (from quotation to commissioning).

By mapping the cost elements of the delivery, managers can accurately find out the actualized costs of a project, and know that how much estimated costs differ from the actualized. If the difference is considerable, the margin of the project is compromised.

Cost element mapping can also be used to evaluate the performance throughout the supply chain. It can also reveal how the costs and benefits are divided between the supply chain partners, and who controls the costs.

The second sub problem was:

2. **What kind of strategies are suitable for the delivery, in the terms of costs and risks?**

A suitable strategy for the delivery should be based on costs and delivery time. There are also other elements that need to be considered, such as quality and technological risks and risks of damaging the products. These elements that cannot be explained through cost information, and thus other information sources should be used as well.

The risks of the deliveries should always be either transferred, mitigated or eliminated, if possible. Counterparty risks should be eliminated by using a LC or by requiring a front payment, if there is any doubt of the customer's solvency. The risks of detention or demurrage costs should be avoided with SOCs if the customer is willing to pay for the containers. In situations where COCs are used, the COCs should only be ordered after the customer has paid for the plant or an LC has been made, if it's a first-time deal. If the customer is a long-term partner, the transportation should be started as agreed.

For minimizing the supply chain costs, it would be beneficial that each activity should be performed by the organization that is most suitable for it. Even though the risks that are realized does not necessarily concern Metso, in the long term it is beneficial to minimize the costs of supply chain partners.

For minimizing the assembly phase costs in low cost countries, the manpower should be maximized always to cut down the duration of the assembly. This will cut down the

supervising costs that are usually the larges part of the assembly costs. Sensitivity analyses can show the best choices for different countries with different costs. These sensitivity analyses should be conducted together with the distributor or with customer.

The third sub problem was:

3. **What kind of process should be used to price and control the delivery?**

The process should contain different paths for serious and casual inquiries, as the process of getting valid freight rates is time and resource consuming. The quoted price for the customer should be calculated with standardized template that will provide the decision maker accurate costs.

The process should have three important review points. These review points are quotation review, order review and assembly review. In quotation and order review, the previous decisions are double checked before continuing forward. In assembly review, the coming assembly is prepared and needed support materials double checked. The sensitivity analyses for minimizing the assembly costs should be conducted with the dealer or with the customer.

The assembly and commissioning phase of the process should include a report that can be used to subsequently understand that was done, and how much costs did the assembly and commissioning generate. Obviously, the report should include financial measures, but also a verbal description should be included. The verbal information can be used to tell the mistakes that were made if there were any. Costly assemblies do not always mean that it was performed poorly.

The delivery process should have a project manager to oversee the deliveries. The meaning of the project manager should be to better the interaction between different departments, not to perform required activities on the delivery itself.

The main research problem:

Why and how should managers use management accounting information, when designing a process for delivering portable crushing plants?

Management accounting information can be used to derive a variety of benefits that will improve the cost efficiency of the delivery, but also provide tools to measure and control the delivery. It can also be used to accurately price the deliveries, which makes it possible to optimize the amount charged from the customer. If the amount charged is too small, it will consume the margin of the project, making the project less beneficial, meaningless or even lossful. If the charged costs are too high, it might lead to a situation where the deal is lost.

Management accounting information should be used to find out the cost structure of the delivery and the variables that will affect the nature of the delivery. Cost element mapping together with sensitivity analyses are relevant tools for this purpose. The cost structure should be used to price the delivery and as the basis behind the whole process. The cost structure will indicate the effects of different strategic choices, and work as a common language to compare the different effects.

6. CONCLUSIONS

This chapter firstly introduces the conclusions from the empirical part, and compares them to the known patterns in literature. Secondly, this chapter describes the findings that can be used to derive practical benefits for Metso, and contribute to management accounting theory. Lastly, as all case studies, this study should be evaluated and the tests that were introduced by Yin (2014, p. 45-49) should be applied.

6.1 Study findings compared to theory

The cost element mapping done in this study proved that cost information about budgeted and actualized costs was important information, that could be used single out the bad projects, to evaluate the reasons why they were estimated wrongly. According to Hall (2010), Van der Veeken & Wouters (2002) found similar results in their study about operations managers and cost information: "*...budgeted versus actual cost information was crucial for senior managers in managing projects as these managers were responsible for many projects and used up-to-date information on allowable versus actual costs to develop knowledge about which projects were causing problems.*" Even though the knowledge of the problematic projects is sunken information, the projects can be further analyzed, and the cause for the excess should be found. This information can be used to avoid same pitfalls in the future.

Cost element mapping also provided a way to compare different supply chain partners, and to reveal how the costs and benefits are divided. This finding relates to the management implications of LaLonde & Pohlen (1996): "*Companies can target supply chain relationships yielding the greatest contributions for strategic alliances or partnerships while taking actions to reduce or eliminate high cost/low value-added relationships."*

Wouters & Wilderom (2008) conducted a study with the aim to find, which characteristics of a performance-measurement system development process enhance the enabling nature of the performance-measurement system. As cost element mapping was used in this study to evaluate the performance of the portable delivery projects, these two studies are interrelated. The Wouters & Wilderom (2008) study proposed that a development process that is characterized by being experience-based, allowing experimentation and building on employees' professionalism can promote a more enabled performance-measurement system. This study verifies that the development process should be experience-based so that the knowledge of employees can be harvested into use, as the measurement system created in this study was based on the knowledge of Metso's employees. Also, the professionalism of Metso's employees is naturally very relevant to this matter. Another benefit found in this study, was that involving different employees to the development

promoted significantly discussion between different departments and personnel. This study suggests that experience-based development will significantly reduce the effort when implementing the measurement system, as the system will be widely known before the implementation. The last characteristic that Wouters & Wilderom (2008) discussed about was allowing experimentation. As the measurement system created in this study is the first version, the system should be tested and refined in an iterative way, when the implementation of the system starts. Unfortunately, the last characteristic cannot be validated as the impelemntation is done subsequently to this study.

A study by Jordan & Messner (2012) assesses measurement systems and the incompleteness of performance indicators. The main idea of the study was that financial performance indicators could be incomplete if they were used flexibly. In practice, this meant that the indicators did not measure absolutely what it needed to measure, but the indicators were still of use, if they were used in a more qualitative way and the contexts behind the measurements were undestood. Similary, in this study it could be argued that measuring the financial performance of the deliveries is not a complete measurement, as it is impossible to say if the project was a success or not based only on the financial data. The financial data also needs to be understood in its context. The measurements may indicate a problem, but it needs a qualitative approach to find out the real reasons behind those costs.

As the assessment of the strategic choices revealed, accounting information should not be the only source of information that is used to make the strategic choices. Accounting information is a valid choice to evaluate cost risks, but other risks require different kind of information. This finding can be compared to Hall (2010): "*As accounting information is just one part of the wider information set that managers use to perform their work, it is imperative to consider its strengths and weaknesses not in isolation but relative to other sources of information at a manager's disposal.*"

Studying the reports from the assembly phase of the cases revealed that the report should contain financial information, but also a verbal description of what has been done. According to Hall (2010), McKinnon and Bruns (1992) found: "*…that the process of recalling the events and activities that occurred during the period of time covered by an accounting report, and then seeing their success as reported by accounting information, allowed managers to associate events and activities with a level of financial performance. This process provided information about linkages between physical events and financial outcomes that managers could use to update their knowledge of operations*." The findings seem to be identical. This also relates to the theory explained in the previous paragraph, that financial information should be used with other information as well.

6.2 Practical contributions

The largest contribution from this study is the created process with the tools and templates. This process should advance the portable deliveries significantly and provide benefits in costs and delivery times.

Based on the interview with a partner company of Metso, the largest cost benefit could be made by shifting the final assembly of the units to the destination country. This is a valid point as it is costly to fully assemble the units and then dismantle them again. The only reason for this is to make sure that all the parts will fit surely in the destination country. There is an opportunity to perform multiple activity eliminations and achieve cost savings, but it requires further research to know if the cost savings would exceed the risks. The difference between Metso's and the partner company's processes are that the partner company sends batches of hundreds of units every year to a few partners, whereas Metso will send a few plants every year to many different partners. Also, the partner company has its assembling done in Europe, whereas Metso has its assembling done in Asia, where the assembly is less costly.

The information gained from the former cases should be storage in the same place. It should be updated by a collaboration of different departments. One of the hardest and most time-consuming parts of this study was to gather the information related to the cases.

6.3 Theoretical contributions

Supply chain costing by LaLonde & Pohlen (1996) was used to map the cost elements of a portable crushing unit delivery. This study validates the usefullness of the method also in this context by providing multiple benefits to the supply chain. It can also be used to eliminate non-value adding partnerships.

Metso is lacking project supervision in certain deliveries, which will add costs in many activities. Augmenting a new activity such as project management can reduce problems that other organizations face. This is due to the increased supervision of the project in whole. Certain activities that are floating between different departments, such as the supervision of the deliveries, be centralized to the most relevant department, depending on the nature of the activity. The benefits for this is driven from the experience that is gained after completing the activity.

Chaoyang & Ying (2010) argues that there are four ways to reduce SCC. This study adds two methods of control to the originals. The fifth method is called "activity augmentation". Creating a new activity may reduce costs by increasing the performance of others, even though the new activity will also generate costs. The sixth method is called "activity centralization". Sometime activities, that should be performed by a single person or a single organization, are scattered and performed by various persons or departments.

Sometimes the same task is not even performed by the same person repeatedly, which makes the performer to be always in the low end of the experience curve. The solution for this is to bundle similar activities together and find the most suitable person to handle them.

6.4 Evaluation of the study

The study was very much tied to the researcher's daily tasks, and the empirical part of the study promoted sustainable development in many operational tasks. This was due to an increased amount of communication regarding the problems in internal processes. As the study consisted of normal operational tasks, it was not an additional expense to Metso. The study has resulted in significant changes, which will promote cost savings and operational effectiveness in the future. Also, the study worked as a good introduction to Metso's Product Management department.

Industrial corporations often concentrate their efforts on the beginning part of the supply chain, but also the end part pays a significant role, if there are complex deliveries included. One objective of the study was to improve Metso's procedures, and the way to do it was to concentrate on the end part of the supply chain, and drive benefits from a well-controlled delivery. According to Metso, the study helped moving towards a more internally and externally integrated supply chain.

Both studies: Wouters & Wilderom (2008) and Jordan & Messner (2012) suggest ways to address incomplete measurement systems. Wouters & Wilderom (2008) suggest that early experimentation before the actual implementation makes the system less incomplete, whereas Jordan & Messner (2012) suggest that incompleteness can be addressed with flexible ways of using the indicators. The implementation, which is done subsequently to this study, should adapt the methods used in these studies.

The implementation of the created process has slowly started, which can be held as an argument for the applicability of the study. The first part of the implementation was to get the review stages working. Assembly review is the most important and there have been multiple meetings with the aim to prepare the assembly of certain plants. These meetings have involved Metso personnel and distributors so far. The inclusion of customers would be a further improvement. There is evidence that the reviews are important, as in every meeting there are some raised issues.

Metso was particularly enthusiastic of the template that could be used to price deliveries in the future. The template was working well as it was, but suddenly new ideas and propositions started to flow. The propositions suggested how to further improve the tool and what kind of qualities it should contain.

This study would have benefitted from Metso's partners that would have been completely willing to open their books for Metso. This should have been agreed on before the study was started. By time to time, there were difficulties to get exact answers and some costs were calculated from expert estimations. Even though the study was conducted without any intentions of eliminating bad performing partners, it is not irrational behavior for supply chain partners to withhold information and watch their backs. Also, in some cases the problem might be that small distributors lack proper cost reporting systems.

The study could have been conducted in a slightly different and better manner. The most important advice for future thesis workers is that start by studying the relevant research method book. Even though this study was conducted at first without a proper introduction to the methods used in a case study, the methods introduced by Yin (2014) were very similar to the methods used. If the study could be recreated, it would be beneficial to start by finding a relevant research problem, and to create propositions and rival propositions before the empirical data would be gathered. As the method used was to work ground up, it was relatively hard to connect the findings to theory and find relevant research problems. Luckily the supervising professor was able to point the right direction.

The cases (embedded units of analysis) used in this study were carefully screened and they represent different kinds of "normal" cases. There could have been other types of cases as well, but then the study would not have served the purpose of finding solutions to the kind of cases that often occur. The selected cases represent three very different kinds of countries and cultures, even though two of them is in the same market area. The selection of the cases was a success, as all required analyses could be conducted at least from one of the cases.

Yin (2014, p. 45-49) discusses about four logical tests that should be used to determine the quality of a research. The tests are: construct validity, internal validity, external validity and reliability. As mentioned in the research methodology chapter, construct validity can be improved by using multiple sources of evidence, establishing a chain of evidence and having key informants read the draft of the study. Multiple sources were used in this study. The usual way was to gain answers from the interviews and then validate it with secondary data. The secondary data was mostly receipts and invoices, making them hard evidence. Both internal and external sources were used. The chain of evidence is not perfect as the study report does not tell the exact sources where the obtained knowledge was gained. Explaining the complete chain of evidence would have consumed too much time. The last way of improving construct validity was used a lot. Most of the conclusions made from interviews were afterwards checked from the interviewees. The significance of this was highlighted by each correction that the interviewees made.

Good internal validity is a matter of finding causal relationships that justifies the inferences made by the researcher. Internal validity is only related to explanatory or

causal studies. The study is mostly explorative as there have not been similar cases that would study managerial decision-making in the same context, but the patterns found in this study was matched to the patterns found in managerial decision-making situations from different contexts.

External validity is about generalization. The only option for a single case study is to do analytical generalization. The coarse level findings derived from this study can be generalized to similar industrial equipment that can be transported containerized or via Roro. On the other hand, the processes used are bound to the assessed organizations and cannot be generalized to other industrial equipment producing companies. Also, many identical findings have been found from other management accounting researches, but no studies have been conducted in this context.

Reliability tests how well same findings would be found, if another researcher would conduct the same study in the future. Yin (2014, p. 49) states that reliability can be enhanced by using a case study protocol and creating a case study database. A case study database was created and all the used data is stored in one single folder, and this report explains the path of what was done and in which order. What affects negatively to the reliability is that the interviews were not recorded. Although all findings were documented immediately after the interview and the results were verified from interviewees.

6.5 Future possibilities

The portable crushing unit business is one of the most growing business in Metso's scope of products, and there should be further actions to optimize quotation and delivery handling. The next step would be to fully implement the created process, test it, and further develop it. The implementation should achieve cost effectiveness, but more importantly it should minimize the time used to handle the delivery. If a complex tailored plant could be delivered fast to a customer, the price of the plant would be a lesser priority, as the nature of the crushing business dictates. There is a solid cash flow when the plant is active, but when it stops, quick actions and deliveries are mandatory.

Other future researches should be conducted to develop different areas of the deliveries, such as delivery control when delivering from multiple factories, and activity optimization in the destination country (engineering, packaging, support documentation). Also, the created process, with the created tools and templates, provides a possibility to measure the performance of future deliveries. The data from the assembly and commissioning phase, as well as the overall realized costs of the projects should be collected with standardized methods and stored in the same place. Once the gathered data is sufficient, the data can be analyzed to further improve the delivery process.

Another future possibility would be to study the possible benefits from following the costs of a project concurrently with the project. Could there be corrective actions to take to avoid the budged being exceeded, or would it be too late once the increased costs are noticed?

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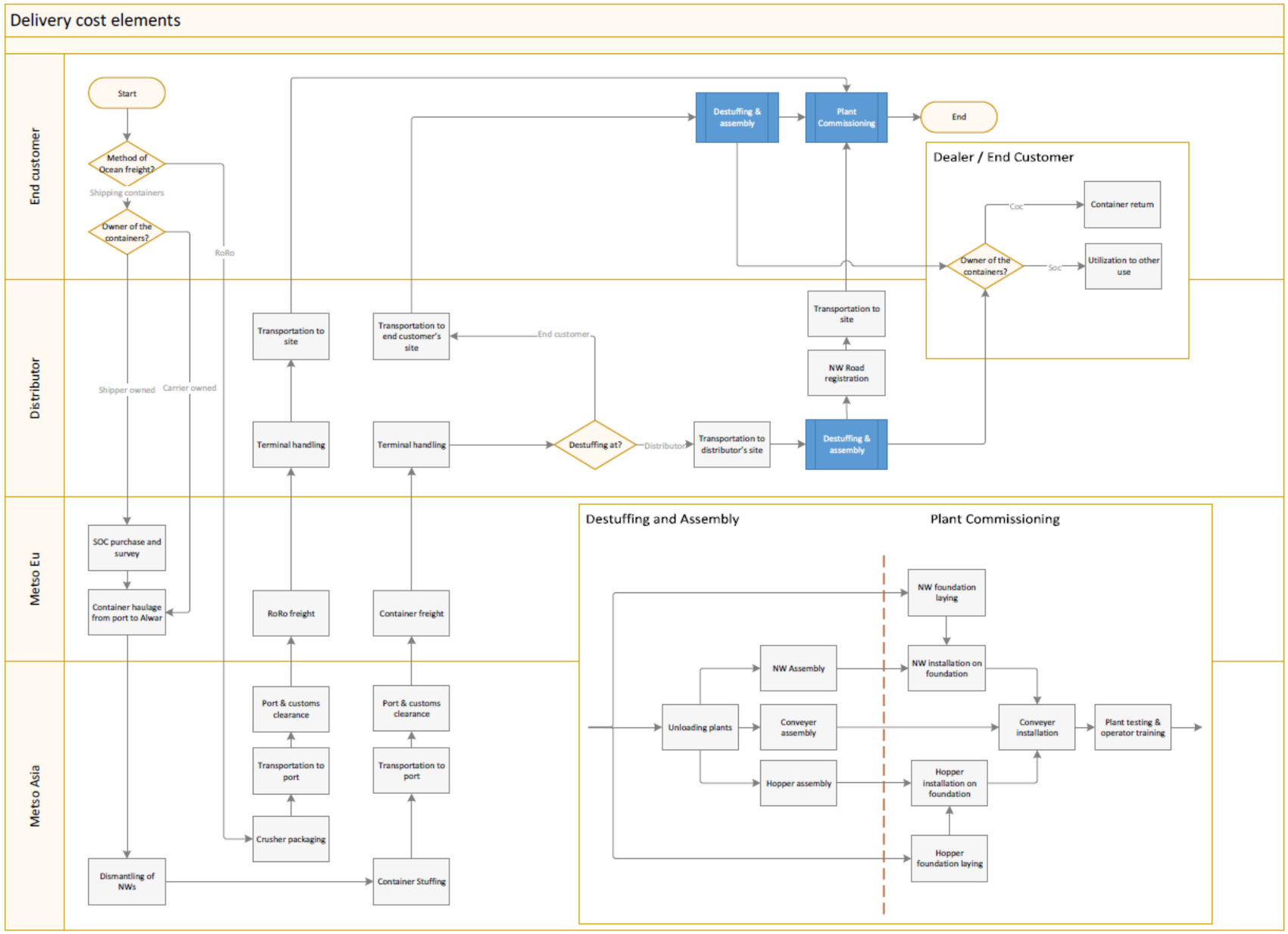
APPENDIX A: DELIVERY COST ELEMENTS



APPENDIX B: CREATED DELIVERY HANDLING PROCESS